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SUMMARY OF PARTICULATE AND SULFUR OXIDE EMISSION REDUCTIONS ACHIEVED NATIONWIDE FOR SELECTED INDUSTRIAL SOURCE CATEGORIES 1970 - 1975

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This research updates the nationwide emission data on total suspended particulates and sulfur oxides from selected source categories for 1975, and the associated analyses to determine the progress made, nationwide, in meeting the ambient air quality standards for the two pollutants under study. The initial inventories and analyses were developed by the Research Triangle Institute under Task Order No. 21, Contract No. 68-02-1325 and reported to EPA in June 1975.* The analyses and inventories developed in the June 1975 studies are updated to reflect changes in SIP requirements proposed or promulgated since the initial study, use of actual 1975 production data in place of projections, and use of compliance status data available in the DSSE Compliance Data System.

This report is publised in two volumes. Volume 1 presents a summary of the emission inventory data and the analyses; Volume II, the detailed calculations, in appendix form, upon which nationwide emission inventories-actual, potential, and compliance-were based.

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SUMMARY OF PARTICULATE AND SULFUR OXIDE EMISSION REDUCTIONS ACHIEVED NATIONWIDE FOR SELECTED INDUSTRIAL SOURCE CATEGORIES, 1970-1975

Volume I

by

Martin F. Massoglia

Prepared for:

Division of Stationary Source Enforcement
Environmental Protection Agency

under

Task Order No. 66, Contract No. 68-02-1325

and

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EPA Project Officer: Robert Marshall

Center for Technology Applications
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FOREWORD

This research was performed for the Division of Stationary Source Enforcement (DSSE), Environmental Protection Agency under Purchase Order No. DA-6-99-5332J and Task Order No. 66, Contract No. 68-02-1325 with the Environmental Protection Agency/Durham. Mr. Robert Marshall, Compliance Monitoring Branch, Division of Stationary Source Enforcement was the EPA Project Officer. His suggestions and comments during the conduct of this research were most helpful.

This research updates the nationwide emission data on total suspended particulates and sulfur oxides from selected source categories for 1975, and the associated analyses to determine the progress made, nationwide, in meeting the ambient air quality standards for the two pollutants under study. The initial inventories and analyses were developed by the Research Triangle Institute under Task Order No. 21, Contract No. 68-02-1325 and reported to EPA in June 1975.* The analyses and inventories developed in the June 1975 studies are updated to reflect changes in SIP requirements proposed or promulgated since the initial study, use of actual 1975 production data in place of projections, and use of compliance status data available in the DSSE Compliance Data System.

This report is published in two volumes. Volume I presents a summary of the emission inventory data and the analyses; Volume II, the detailed calculations, in appendix form, upon which nationwide emission inventories—actual, potential, and compliance—were based.

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*Massoglia, Martin F., Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volumes I and II, Research Triangle Institute, June 1975.

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I. INTRODUCTION AND PURPOSE

Under the Clean Air Act amendments of 1970, the States and EPA are charged with the responsibiljty of reducing the quantity of pollutants in the ambient air to levels adequate to protect public health and welfare. In 1971, EPA identified six pollutants that are deemed harmful to health and welfare in certain concentrations (total suspended particulates, sulfur oxides, nitrogen oxides, carbon monoxide, photo-chemical oxidents, and hydrocarbons) and established National Ambient Air Quality Standards (NAAQS) as levels to be attained and maintained.

The Clean Air Act amendments of 1970 required the States to develop State Implementation Plans (SIP's) by 1972 to assure that the federally established NAAQS are attained and maintained. In order to achieve the NAAQS, States set specific emission regulations in the SIP's restricting the amount of pollutants which any source may introduce into the atmosphere. These limitations on emissions are designed so that when sources comply, there will be a reduction in the ambient concentrations of those six pollutants to levels at least as low as the national ambient standards, taking into account the increase in emissions which occurs as a result of normal industrial growth. Two of these six pollutants, total suspended particulate matter and sulfur oxides, are the principal air pollutants emitted by stationary sources.

This report summarizes the results of five years of local, State, Federal, and industry efforts to reduce the amount of particulates and sulfur oxides being emitted into the atmosphere by stationary sources and points out the remaining work to be done. Data developed for a previous similar study*, modified and updated, are used as the bases for the analyses of selected industrial source categories. Modification and update include consideration of changes to SIP requirements proposed or promulgated by the States and EPA, use of actual 1975 production data as reported by Bureau of Mines, other governmental agencies, and trade associations rather than projecting previous year data using growth factors published in the literature, and use of Compliance Data Systems data on degree of compliance rather than estimates from the literature. These revised and updated data are used to measure reduction in emissions of particulates and sulfur oxides and to illustrate the progress achieved through 1975.†

Throughout this study, emissions are referred to as either "potential" or "actual." Potential emissions are defined as those that would have occurred without any controls. Included in potential emissions is the increase that would have resulted from normal industrial growth between 1970 and 1975. In

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*Summary of Emission Reductions Achieved Nationwide by Selected Industrial Source Categories, Volumes I & II, Martin F. Massoglia, Research Triangle Institute, June 1975, U.S. Environmental Protection Agency Contract No. 68-02-1325, Task No. 21.

†Sources of data are documented in Volume II of this study.

some of the industry categories included in this study, 1975 activity (and thus potential emissions) were less than that existing in 1970. This is considered in the analyses of industrial source categories. Actual emissions, on the other hand, represent reduced emission levels that in fact resulted from the use of emission controls. Compliance emissions or compliance level, a special case of actual emissions, represent the emissions estimated to result when all plants within an industrial source category are in compliance with the emission limitations of the applicable regulations. It should be noted that compliance emissions are calculated using reported 1975 activity data. Compliance emissions for subsequent years may be somewhat higher because of growth between 1975 and the year of interest. In some of the industrial source categories this could be significant, especially those that experienced a significant decline in activity between 1970 and 1975. For example, steel production declined 10.9 percent during this period (131.1 x 10^6 tons to 116.8 x 10^6 tons), pig iron production declined 12.5 percent (91.4 x 10^6 tons to 79.9 x 10^6 tons), and Portland Cement plants 8.5 percent (76.5 x 10^6 tons to 70.0 x 10^6 tons). Thus, the estimates of emission prevented by Federal and State programs would be higher in years beyond 1975 as the industries under study begin to pick up production that was curtailed between 1970 and 1975.

Appendix A to this study describes the procedures used to estimate potential, actual, and compliance emissions. Volume II of this report contains the detailed calculations and documents the sources of the input data used in making emissions estimates.

These estimates are useful in providing a surrogate measurement of progress toward the attainment of the NAAQS. They are also useful in assessing the impact of pollution control programs on the reduction of emission rates in specific, key industries and in identifying those industries where relatively less progress has been made toward meeting the full compliance levels. Although a national summary of this sort is valuable as an overall indicator of progress for specific industries and the Nation, the nature of the results--that is, average emission rates and average compliance levels for an entire industry--do NOT lend themselves to direct application to a specific facility or a local geographic area.

II. FINDINGS

The results are presented in three sections: section A, Particulate Results for the Nation; section B, Sulfur Oxide Results for the Nation; and section C, Industry-by-Industry Results. Since some of the industries analyzed have significant emissions for only one of the two pollutants studied, an analysis of the less significant pollutant is omitted for those industries.

A. Particulate Results for the Nation

Potential and actual particulate emissions for 1970 and 1975 and compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards are shown in figure 1 and listed in tables 1 and 2.

Between 1970 and 1975, potential particulate emissions increased by 12 percent from 98.5 million tons per year to 110.4 million tons per year as a

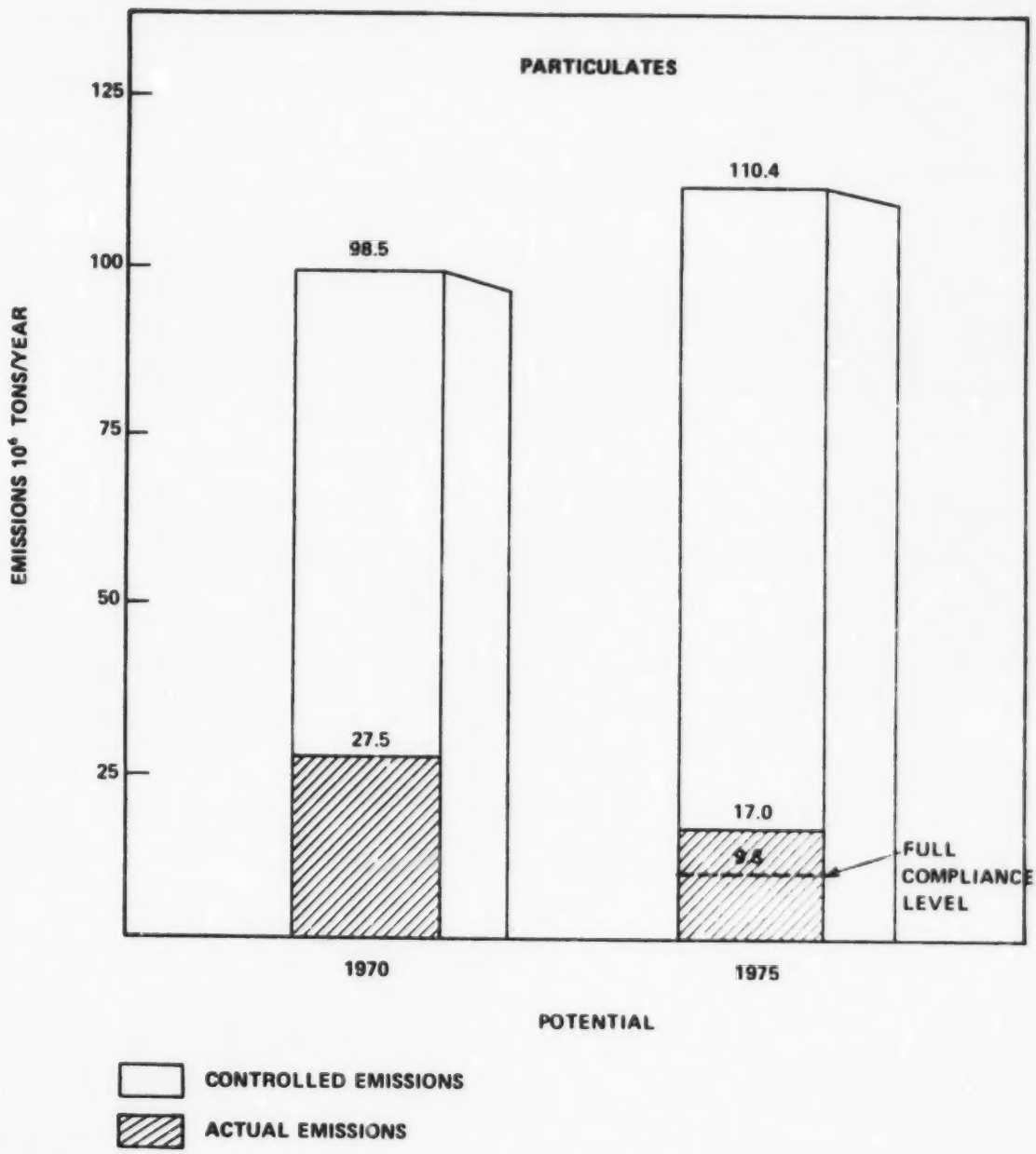

Figure 1. National Particulate Emissions

Table 1

SUMMARY OF POTENTIAL AND ACTUAL EMISSION ESTIMATES
FOR TOTAL SUSPENDED PARTICULATES

Emissions 10^3 tons

Source Category	1970		1975		
	Potential	Actual	Potential	Actual	Full Compliance
Coal-Fired Steam-Electric Power Plants	34,533	4,188	49,352	3,760	756
Oil-Fired Steam-Electric Power Plants	54	54	80	80	80
Coal-Fired Industrial/Commerical Boilers	4,501	2,545	3,959	1,287	401
Integrated Iron and Steel Mills and Coke Plants	15,259	2,346	12,760	1,469	386
Petroleum Refineries	283	136	324	148	146
Primary Smelters	1,637	190	1,553	145	100
Portland Cement Plants	10,643	906	9,604	305	66
Municipal Refuse Incinerators	184	105	203	73	16
Phosphate Fertilizer Plants	172	24	167	14	12
Ferroalloy Plants	366	71	313	34	29
Asphalt Concrete Plants	6,998	526	7,068	203	120
Coal-Cleaning Plants	671	217	372	35	11
Kraft and Sulfite Pulp Mills	3,133	288	3,789	146	38
Grey Iron Foundries	1,320	156	899	62	46
Subtotal Selected Source Categories	79,754	11,752	90,463	7,761	2,207
All Sources	98,479	27,500(1)	110,339	17,000(2)	9,798

(1) NADB Internal Paper. Air Pollution Estimates, 1970-1974.

(2) Preliminary NADB estimates provided by C. Mann, NADB.

Table 2

TOTAL SUSPENDED PARTICULATES

Source Category	% of Total Actual 1975 Emissions	Average % Control in 1975	% of Compliance Objective	Total Reduction Remaining 10^3 tons	(%)
Coal-Fired Steam-Electric Power Plants	22	92	84	3,004	(16)
Oil-Fired Steam-Electric Power Plants	<1	*	*	*	(*)
Coal-Fired Industrial/Commerical Boilers	8	67	59	886	(41)
Integrated Iron and Steel Mills and Coke Plants	9	88	45	1,083	(55)
Petroleum Refineries	<1	54	95	2	(5)
Primary Smelters	<1	91	50	45	(50)
Portland Cement Plants	2	97	72	239	(28)
Municipal Refuse Incinerators	<1	64	47	57	(53)
Phosphate Fertilizer Plants	<1	92	83	2	(17)
Ferroalloy Plants	<1	89	88	5	(12)
Asphalt Concrete Plants	<1	97	83	83	(17)
Coal-Cleaning Plants	<1	91	88	24	(12)
Kraft and Sulfite Pulp Mills	<1	96	88	108	(12)
Grey Iron Foundries	<1	93	84	16	(16)
Subtotal Selected Source Categories	46	91	73	5,554	(27)
All Sources	100	85	76	7,202	(24)

*The national average emissions calculations indicate that no control is required even though specific situations may exact where state/local regulation are applicable and require some control.

result of the industrial growth during the period. This growth of potential emissions made an absolute reduction in actual emissions more difficult. The 38 percent actual emissions reduction achieved (to 17.0 million tons per year in 1975 from 27.5 million tons per year in 1970) was possible only because abatement programs increased the overall degree of control from 72 percent in 1970 to 85 percent in 1975. By the end of 1975, some 22.4 million tons per year of particulates were being controlled that were not controlled in 1970.

The SIP's were designed to achieve ambient air quality standards by controlling particulate emissions to an actual emission level of 9.8 million tons per year based on an estimated 1975 potential emission level of 110.4 million tons. This is equivalent to an overall degree of control of 91 percent. Full compliance with emission limitations would therefore result in the control of 29.6 tons per year of particulates that were not under control in 1970. Emission reductions through 1975 represent 73 percent of the compliance objective for the 14 selected source categories listed in table 1 and 76 percent for emissions from all sources.

Examination of table 2 shows that for particulates the industries that need the greatest amount of additional control, in terms of absolute emission reductions, to meet full compliance requirements are coal-fired steam-electric power plants, and integrated iron and steel mills and coke plants. Each individual industrial source category is discussed in section C.

B. Sulfur Oxide Results for the Nation

Potential and actual sulfur oxide emissions for 1970 and 1975 and compliance level emissions, based on 1975 activity, for the attainment of ambient air quality standards are shown in figure 2 and listed in tables 3 and 4.

Between 1970 and 1975, as a result of industrial growth during the period, potential sulfur oxide emissions increased by 15 percent from 39.6 million tons per year to 45.6 million tons per year. This growth in potential emissions made an absolute reduction in actual emissions more difficult to achieve. Nevertheless, the overall degree of control for sulfur oxide emissions increased from 13 percent in 1970 to 28 percent in 1975. This resulted in a 4 percent reduction in actual emissions (to 32.9 million tons per year in 1975 from 34.3 million tons per year in 1970). By the end of 1975, 7.4 million tons per year of sulfur oxides were being controlled that were not under control in 1970.

The SIP's were designed to achieve ambient air quality standards by controlling sulfur oxide emissions to an actual emission level of 26.6 million tons per year, based on an estimated 1975 potential emission level of 45.6 million tons. This is equivalent to an overall degree of control of 42 percent. Full compliance with emission limitations would, therefore, result in the control of 13.8 million tons per year of sulfur oxides that were not under control in 1970. Emission reductions through 1975 represent 54 percent of the compliance objective. For the eight selected industrial categories listed in table 3, the emission reductions through 1975 represent 64 percent of the compliance objective.

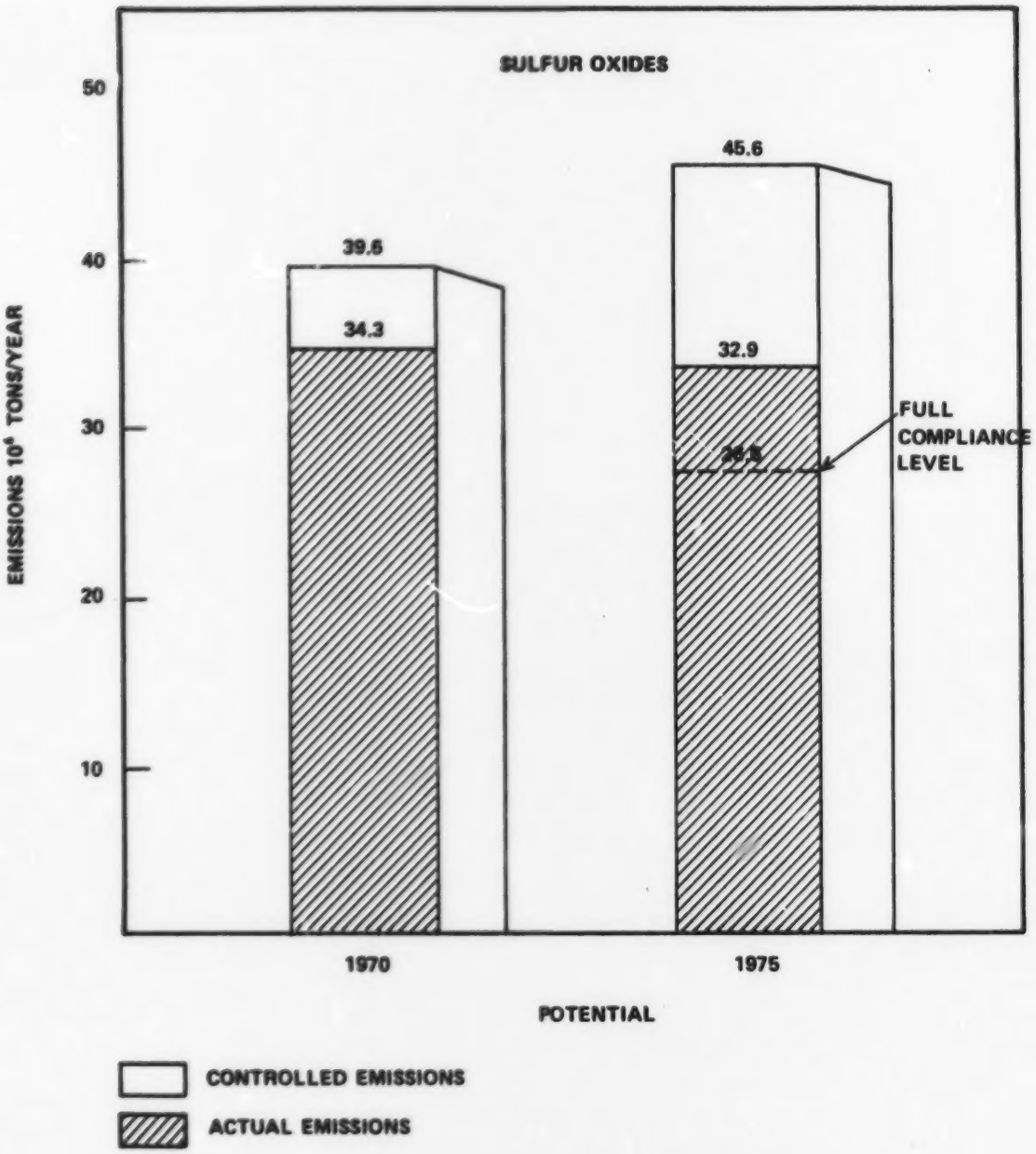

Figure 2. National Sulfur Oxides Emissions

Table 3

SUMMARY OF POTENTIAL AND ACTUAL EMISSION ESTIMATES
FOR SULFUR OXIDES

Emissions 10^3 tons

Source Category	1970		1975		
	Potential	Actual	Potential	Actual	Full Compliance
Coal-Fired Steam-Electric Power Plants	15,439	15,439	20,971	13,536	11,481
Oil-Fired Steam-Electric Power Plant	1,618	1,618	2,022	1,692	1,555
Coal-Fired Industrial/Commercial Boilers	5,529	5,529	5,131	3,530	2,788
Integrated Iron and Steel Mills and Coke Plants	197	180	173	110	25
Petroleum Refineries(1)	1,537	1,537	1,759	1,498	1,312
Primary Smelters	4,845	3,580	4,629	2,965	603
Portland Cement Plants	733	733	661	661	661
Sulfuric Acid Plants	581	581	626	350	183
Subtotal Selected Source Categories	30,479	29,197	35,972	24,342	18,608
All Sources	39,586	34,300(2)	45,639	32,900(3)	26,568

(1) For the purposes of this study, Claus plants are considered as integral to refinery operations and not as control techniques.

(2) NADB Internal Paper. Air Pollution Estimates, 1970-1974.

(3) Preliminary 1975 estimates provided by C. Mann, NADB.

Table 4

SULFUR OXIDES

Source Categories	% of Total Actual 1975 Emissions	Average % Control in 1975	% of Compliance Objective Achieved	Total Reduction Remaining 10^3 tons	(%)
Coal-Fired Steam-Electric Power Plants	41	35	78	2,055	(22)
Oil-Fired Steam-Electric Power Plants	5	16	71	137	(29)
Coal-Fired Industrial/Commerical Boilers	11	31	73	742	(27)
Integrated Iron and Steel Mills and Coke Plants	<1	36	45	85	(55)
Petroleum Refineries**	5	15	58	186	(42)
Primary Smelters	9	36	21	2,362	(79)
Portland Cement Plants	2	*	*	*	(*)
Sulfuric Acid Plants	1	44	62	167	(38)
Total Selected Source Categories	74	32	64	5,734	(36)
All Sources	100	28	54	6,332	(46)

*The national average emissions calculations indicate that no control is required even though specific situation may exist where State/local requlations are applicable and require some control.

**For the purposes of this study, Claus plants are considered as integral to refinery operations and not as control techniques.

Examination of table 4 shows that for sulfur oxides the industries that need the greatest amount of additional control, in terms of absolute emission reduction to meet full compliance, are coal-fired steam-electric power plants, primary smelters, and coal-fired industrial/commercial boilers. In this study Claus sulfur recovery units are considered as a component of petroleum refineries resulting in an apparent reduction in enforcement requirements. However, the overall potential emissions from refinery operations, especially if Claus operations are curtailed or modified, suggest that petroleum refineries be included in the listing of source categories requiring the greatest amount of additional control. Each individual industry is discussed in section C of this report.

C. Industry-by-Industry Results

1. Coal-Fired Steam-Electric Power Plants.

Examination of tables 1 and 3 shows that coal-fired power plants are, as an industrial category, by far the largest potential and actual source of particulates and sulfur oxides in the country, accounting for 22 percent of all actual particulate emissions and 41 percent of all actual sulfur oxide emissions from stationary sources in 1975. Figures 3A and 3B illustrate actual and potential particulate and sulfur oxide emissions for 1970 and 1975, and full compliance level emissions, based on 1971 activity, under the SIP's for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1974, as a result of the expansion of coal-fired electrical generation capacity, potential emissions increased by 43 percent (to 49.4 million tons per year in 1975 from 34.5 million tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 88 percent by 1970. By 1975 the overall degree of control had increased to 92 percent and had resulted in a 10 percent reduction in actual emissions (to 3.8 million tons per year in 1975 from 4.2 million tons per year in 1970). Translated to reduction in emissions, 15.2 million tons per year of particulates from coal-fired steam-electric power plants were under control in 1975 that were not under control in 1970.

Full compliance with emission limitations, based on an estimated 1975 potential emission level of 49.4 million tons, will require 98 percent control to 0.8 million tons per year. At the compliance level, 18.3 million tons of particulates from coal-fired steam-electric power plants will be under control that were not under control in 1970. Through 1975, 84 percent of the compliance level for particulates had been achieved.

Sulfur Oxides--Between 1970 and 1975, as a result of expansion of coal-fired electrical generation capacity, potential emissions increased by 36 percent (to 21.0 million tons per year in 1975 from 15.4 million tons per year in 1970). Potential sulfur oxide emissions used in this report are based on fuel consumption and therefore do not indicate prior emission reductions achieved through fuel switching. Because there was little, if any, stack gas cleaning techniques prior to 1970, actual emissions were considered to be uncontrolled and the same as potential emissions in 1970. By 1975, a 35 percent overall

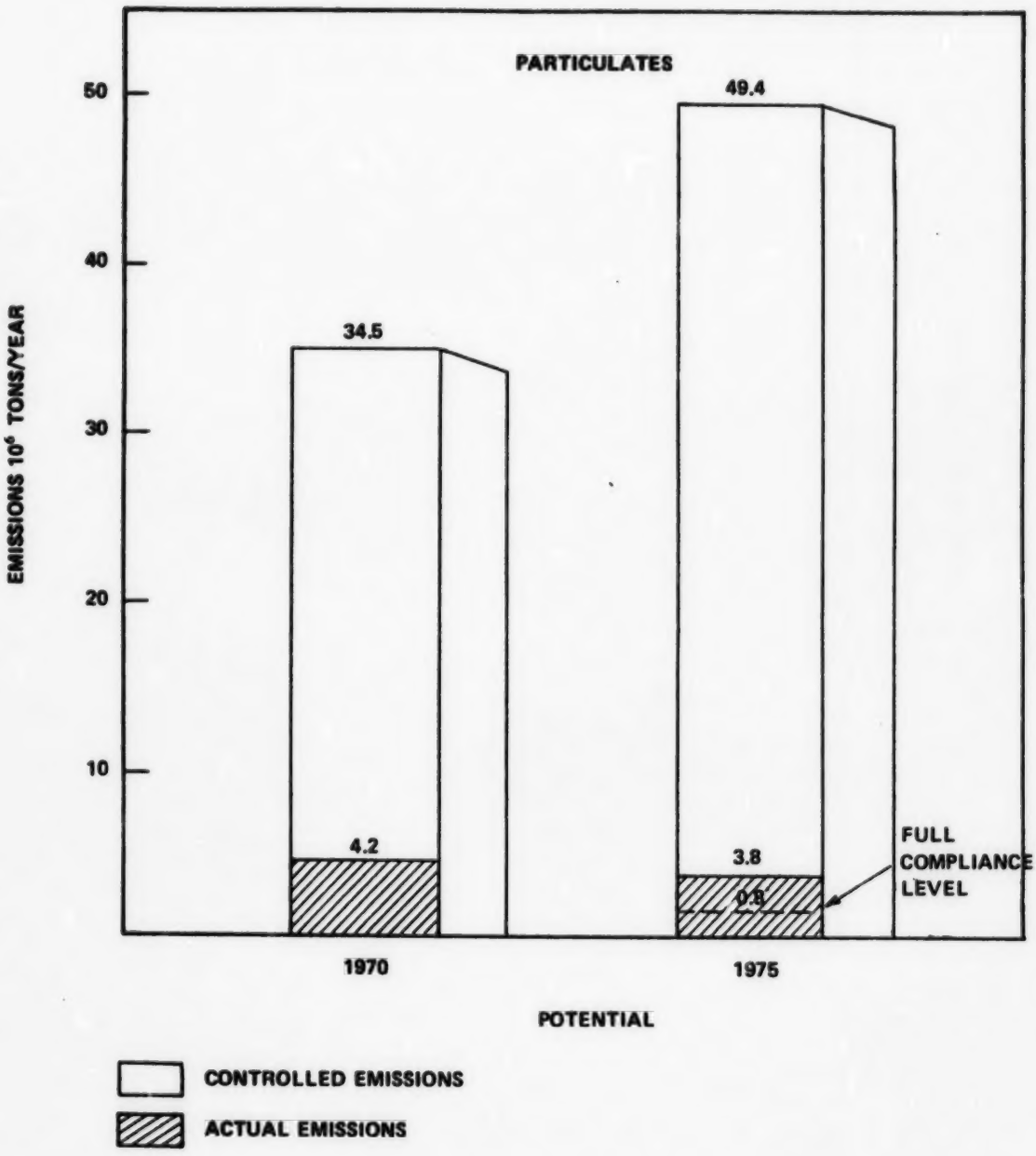

Figure 3A. Coal Fired Steam-Electric Power Plants

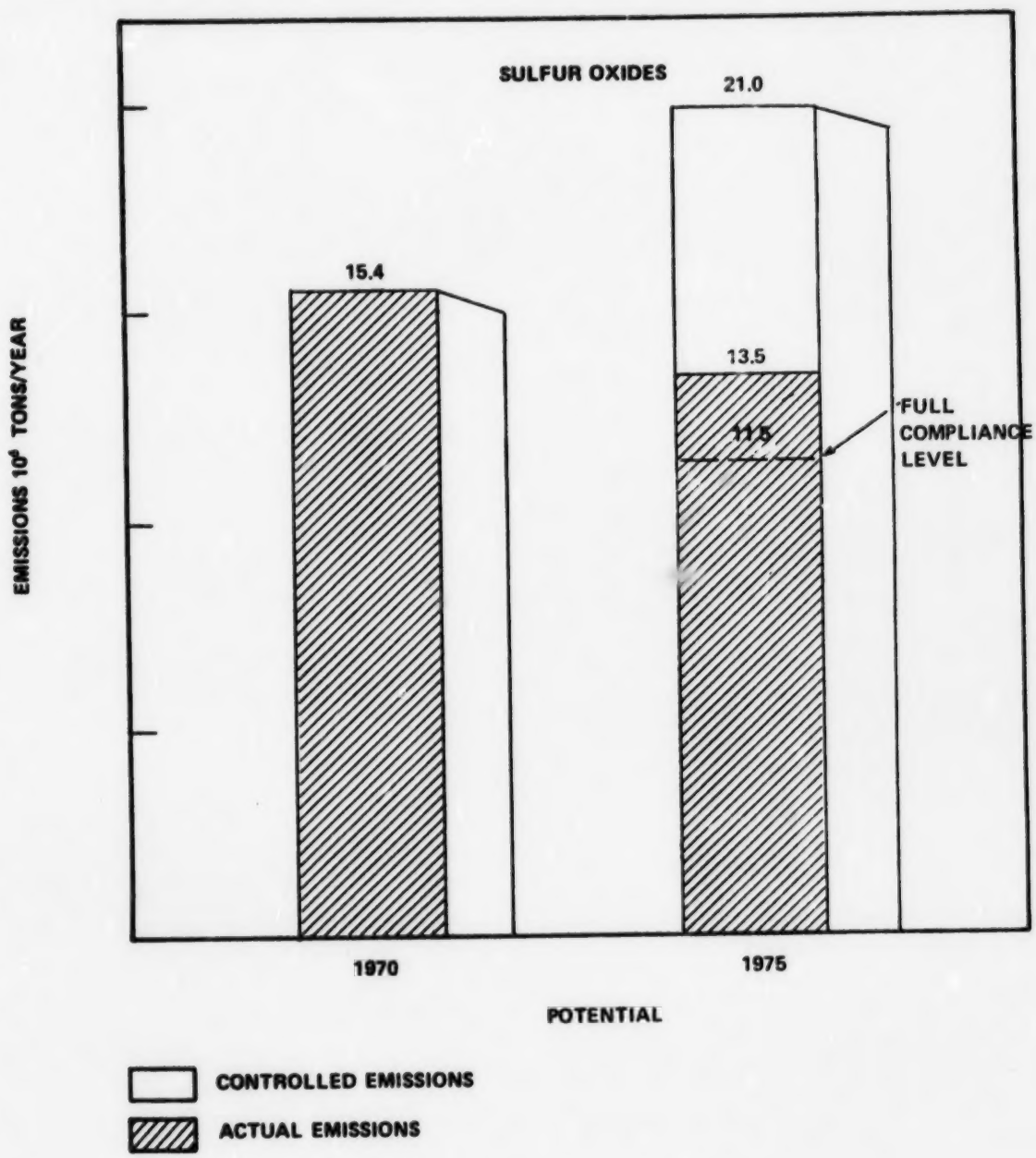

Figure 3B. Coal-Fired Steam-Electric Power Plants

degree of control had been realized, mainly through switching to lower sulfur fuels and by the use of flue gas desulfurizing systems. As a result, 7.4 million tons per year of sulfur oxides were being controlled in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 21.0 million tons, will require 45 percent control to 11.5 million tons per year. At the compliance level, 9.5 million tons of sulfur oxides from coal-fired steam-electric power plants will be under control that were not under control in 1970. Through 1975, 78 percent of the compliance level for sulfur oxides had been achieved.

2. Oil-Fired Steam-Electric Power Plants.

Examination of tables 1 and 3 shows that oil-fired power plants accounted for about 1/2 percent of all actual particulate emissions and for 5 percent of all actual sulfur oxide emissions in 1975. Figures 4A and 4B illustrate potential and actual particulate and sulfur oxide emissions for 1970 and 1975, and also show potential level emissions, based on 1975 activity, for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, as a result of the large increase in oil consumption, potential emissions increased by 48 percent (to 80 thousand tons per year in 1975 from 54 thousand tons per year in 1970). To calculate actual particulate emissions for oil-fired steam-electric power plants, SIP regulations for those States accounting for over 75 percent of oil consumption for electric generation were analyzed. When the national average allowable emission rate was calculated, potential emissions for particulates were found to be less than the allowable rate for each year under consideration. This comparison indicates that, on the average, no control of particulates is required. Therefore, actual emissions were assumed to be uncontrolled and to be the same as potential emission. This is illustrated in figure 4A. Although potential particulate emissions from oil-fired power plants are below the full compliance level on a national basis, there may be localized problems where more stringent local regulations may require some particulate control.

Sulfur Oxides--Between 1970 and 1975, as a result of the increase in oil consumption by electric generation plants, potential emissions increased by 25 percent (to 2.02 million tons per year in 1975 from 1.62 million tons per year in 1970). Potential sulfur oxide emissions used in this report are based on 1970 fuel sulfur content values and therefore do not reflect emission reduction achieved in prior years through switching to lower sulfur oils. Because prior emission reductions are not indicated and little if any stack gas cleaning was used in 1970, actual emissions for 1970 were assumed to be uncontrolled and to be the same as potential emission. By 1975 a 16 percent degree of control had been realized primarily through switching to lower sulfur fuels and by the use of flue gas desulfurizing systems. As a result, 330,000 tons per year of sulfur oxides were being controlled that were not under control in 1970.

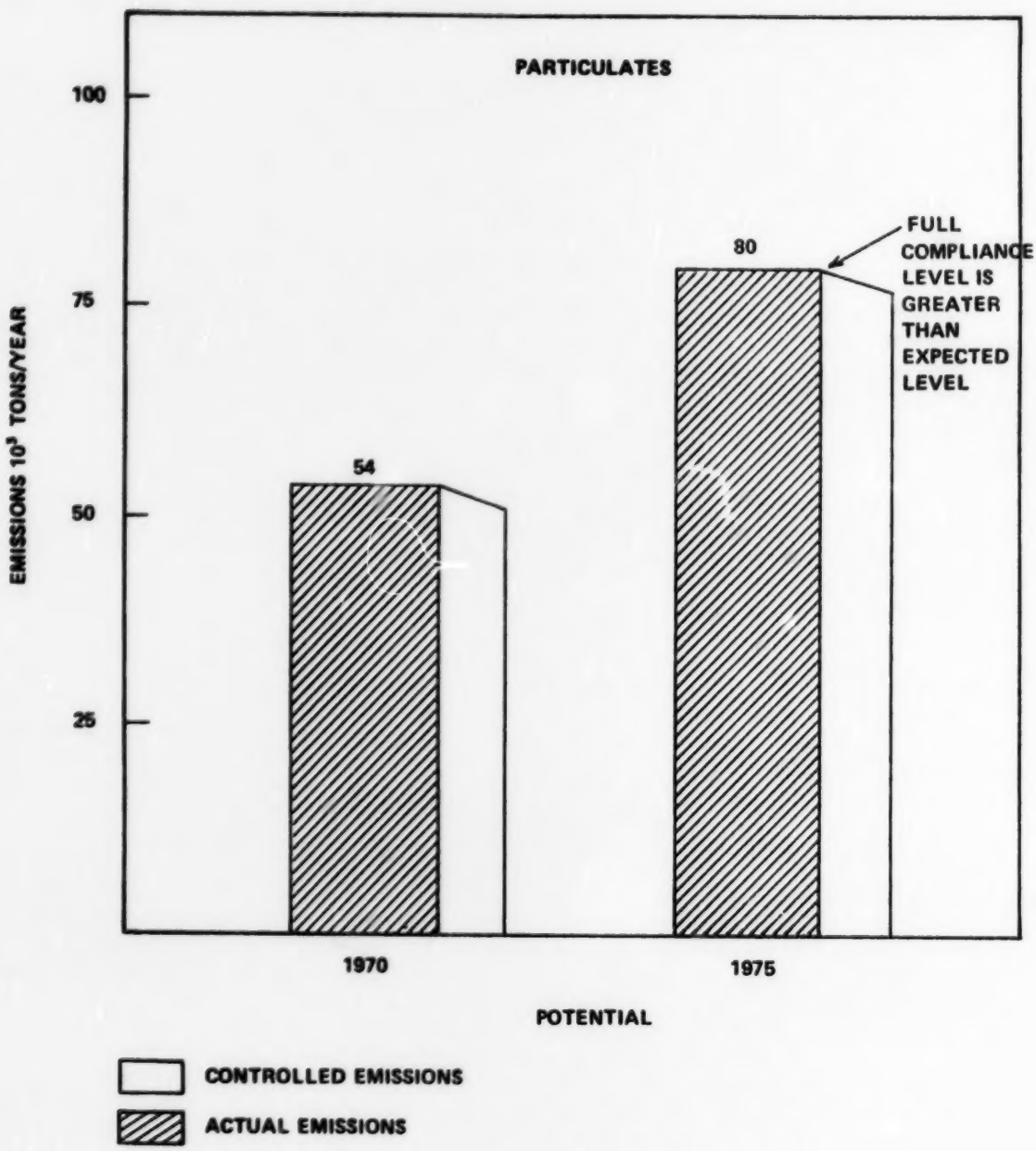

Figure 4A. Oil-Fired Steam-Electric Power Plants

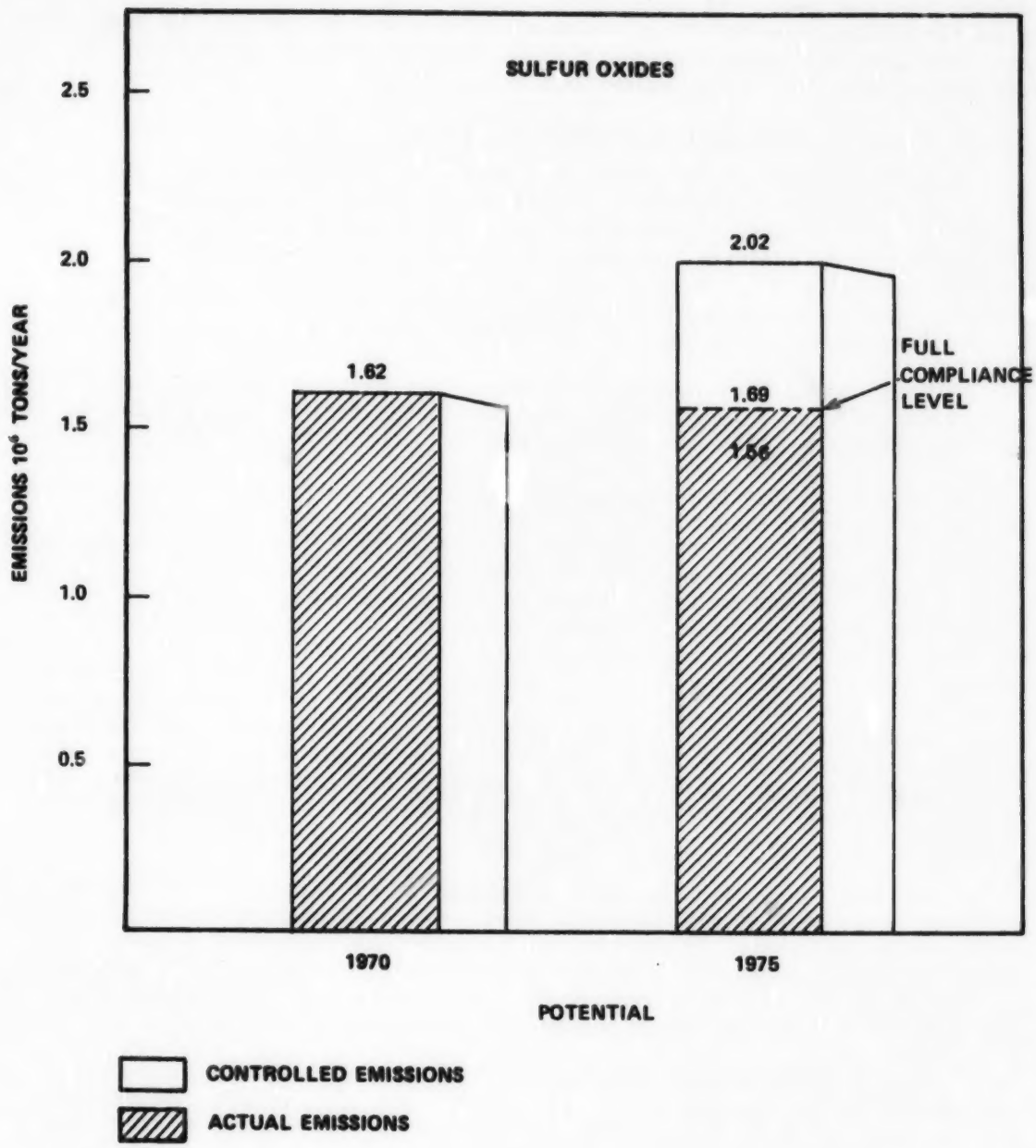

Figure 4B. Oil-Fired Steam-Electric Power Plants

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 2.02 million tons, will require 23 percent control to 1.56 million tons per year. At compliance with emission limitations, 467,000 tons of sulfur oxides from oil-fired steam-electric power plants will be under control that were not under control in 1970. Through 1975, 71 percent of the compliance level for sulfur oxides had been achieved.

3. Coal-fired Industrial/Commercial Boilers.

Coal-fired industrial/commercial boilers are located at facilities in a number of industrial categories and plants. Emissions for the other industrial categories do not include emissions from coal-fired boilers which are covered here. In addition, emissions from coal-fired power plants which are covered in section C.1. of this report are not included here. As a source category, coal-fired industrial/commercial boilers accounted for 8 percent of all particulate and 11 percent of all actual sulfur oxide emissions in 1975.

Figures 5A and 5B illustrate actual and potential particulate and sulfur oxide emissions for 1970 and 1975, and compliance level emissions based on 1971 activity under the SIP's for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, because of a decline in coal consumption by all sources except utilities, potential emissions decreased by 12 percent (to 3.96 million tons per year in 1975 from 4.50 million tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 45 percent by 1970. By 1975 through additional use of pollution control equipment, the overall degree of control had increased to 67 percent and had resulted in a 49 percent reduction in actual emissions (to 1.29 million tons per year in 1975 from 2.55 million tons per year in 1970). Translated to reduction in emissions, 1.26 million tons per year of particulates from coal-fired commercial/industrial borders were under control in 1975 that were not under control in 1970. A large part of this reduction is due to a decrease in potential emissions as a result of a number of plants switching from coal to oil and the replacement of old coal boilers with oil-fired units in other plants.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 3.96 million tons, will require 90 percent control to 0.40 million tons per year. At the compliance levels, 2.14 million tons of particulates from coal-fired industrial/commercial boilers will be under control that were not under control in 1970. Through 1975, 59 percent of the compliance level for particulates had been achieved.

Sulfur Oxides--Between 1970 and 1975, because of a decrease in coal consumption by all sources except utilities, potential emissions decreased by 7 percent (to 5.13 million tons per year in 1975 from 5.53 million tons per year in 1970). Emission reductions achieved through fuel switching are not indicated in these data because 1970 sulfur content values were used to calculate potential emissions. Because there were no controls such as gas cleaning in 1970, actual sulfur oxide emissions are assumed to be uncontrolled and the same as potential emissions. By 1975 the overall degree of control

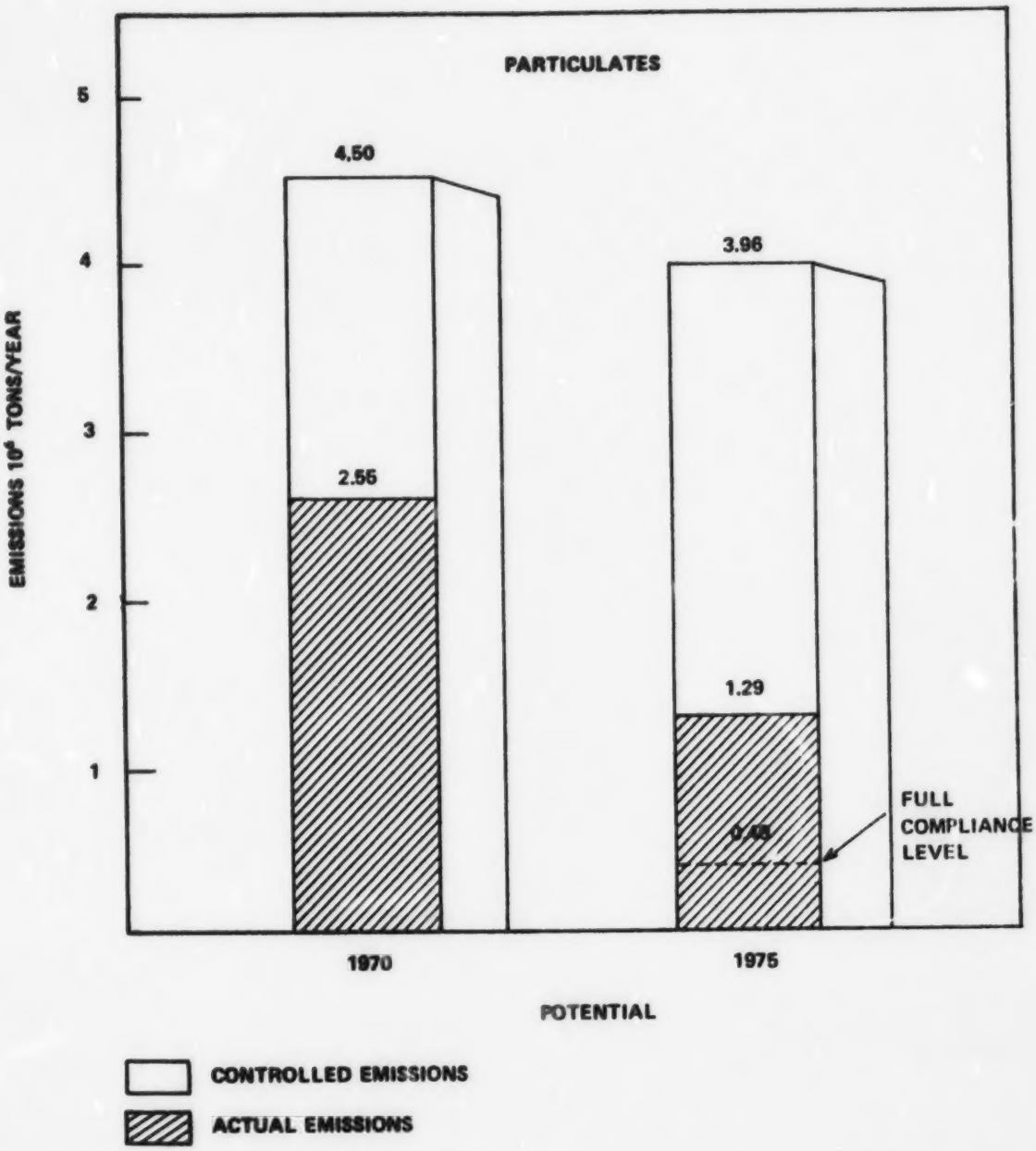

Figure 5A. Coal-Fired Industrial/Commercial Boilers

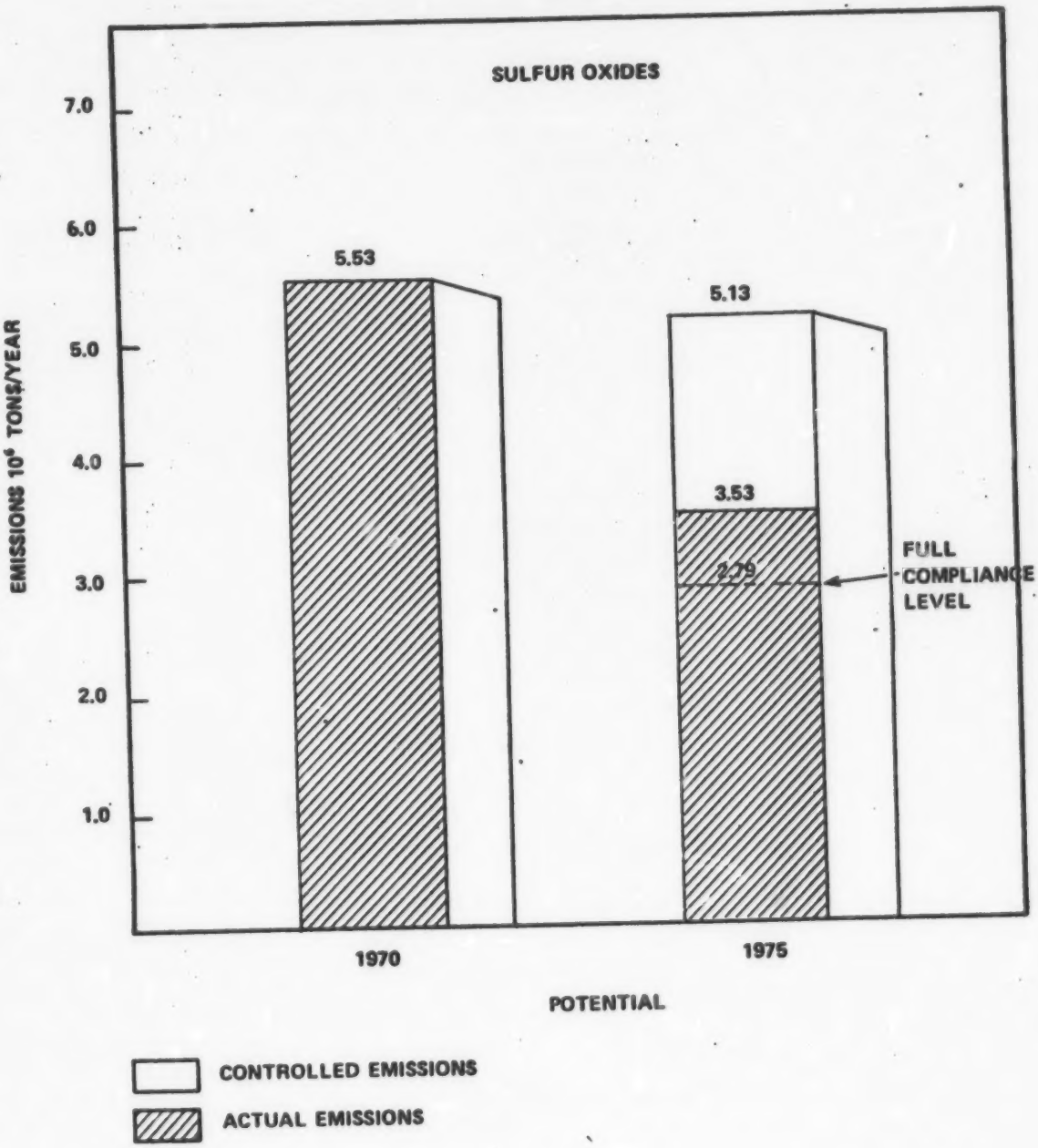

Figure 5B. Coal-Fired Industrial/Commercial Boilers

had increased to 31 percent and had resulted in a 36 percent reduction in actual emissions (to 3.53 tons per year in 1975 from 5.53 tons per year in 1970). Translated to reduction in emissions, 2.00 million tons per year of sulfur oxides from coal-fired industrial/commercial boilers were under control in 1975 that were not under control in 1970. While a part of the actual emission reduction resulted from a decrease in potential emissions between 1970 and 1973, 1.60 million tons reduction can be attributed to the application of controls to the process between 1970 and 1975.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 5.13 million tons per year, will require 46 percent control to 2.79 million tons per year. At compliance with emission limitations, 2.74 million tons of sulfur oxides from coal-fired industrial/commercial boilers will be under control that were not under control in 1970. Through 1975, 73 percent of the compliance level for sulfur oxides had been achieved.

4. Integrated Iron and Steel Mills and Coke Plants.

Integrated iron and steel mills and coke plants accounted for 9 percent of all actual particulate emissions and less than 1 percent of all actual sulfur oxide emissions in 1975. Figures 6A and 6B illustrate potential and actual particulate and sulfur oxide emissions for 1970 and 1975 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, as a result of an overall slump in the Nation's economy, potential emissions decreased by 16 percent (to 12.8 million tons per year in 1975 from 15.3 million tons per year in 1970). Existing abatement programs had achieved an overall degree of control of 85 percent by 1970. By 1975 the overall degree of control had increased to 88 percent and had resulted in a 35 percent reduction in actual emissions (to 1.5 million tons per year in 1975 from 2.3 million tons per year in 1970). Translated to reduction in emissions, 800,000 tons per year of particulate from integrated iron and steel mills and coke plants were under control in 1975 that were not under control in 1970. A portion of this decrease is due to a decrease in potential emissions because of reduced activity.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 12.8 million tons, will require 97 percent control to 0.4 million tons per year. At compliance with emission limitations, 2.0 million tons of particulates from integrated iron and steel mills and coke plants will be under control that were not under control in 1970. Through 1975, 45 percent of the compliance level for particulates had been achieved.

Sulfur Oxides--Most of the sulfur oxide emissions from steel mills are the result of burning coke oven gas that had not been desulfurized and coal-fired boilers. Sulfur oxides from the latter are not included here but are subsumed in emissions from coal-fired industrial/commercial boilers (see section C.3). Between 1970 and 1975, potential emissions decreased by 12 percent (to 173,000 tons per year in 1975 from 197,000 tons per year in 1970). By 1975 the overall degree of control had increased to 36 percent and had

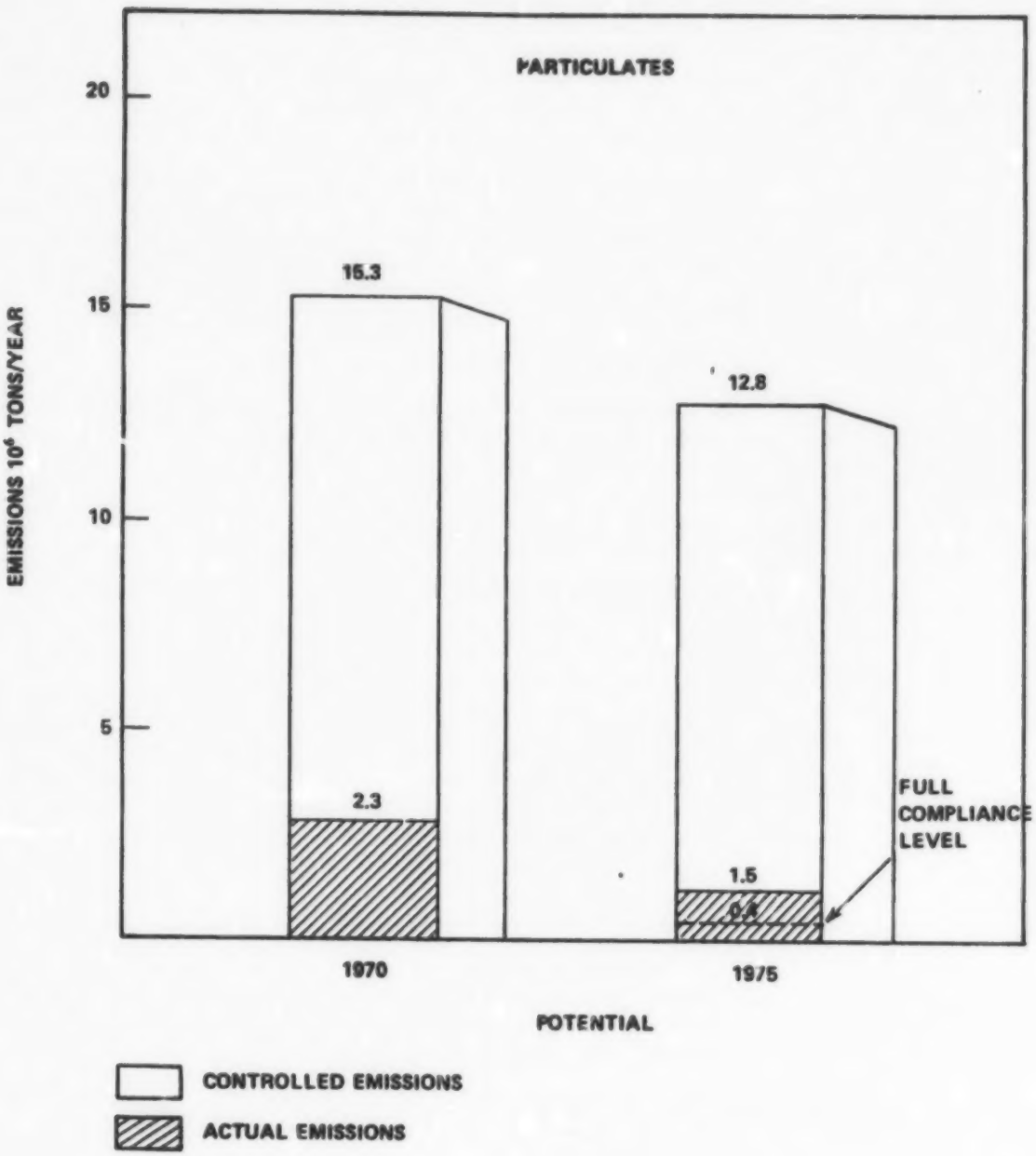

Figure 6A. Integrated Iron and Steel Mills and Coke Plants

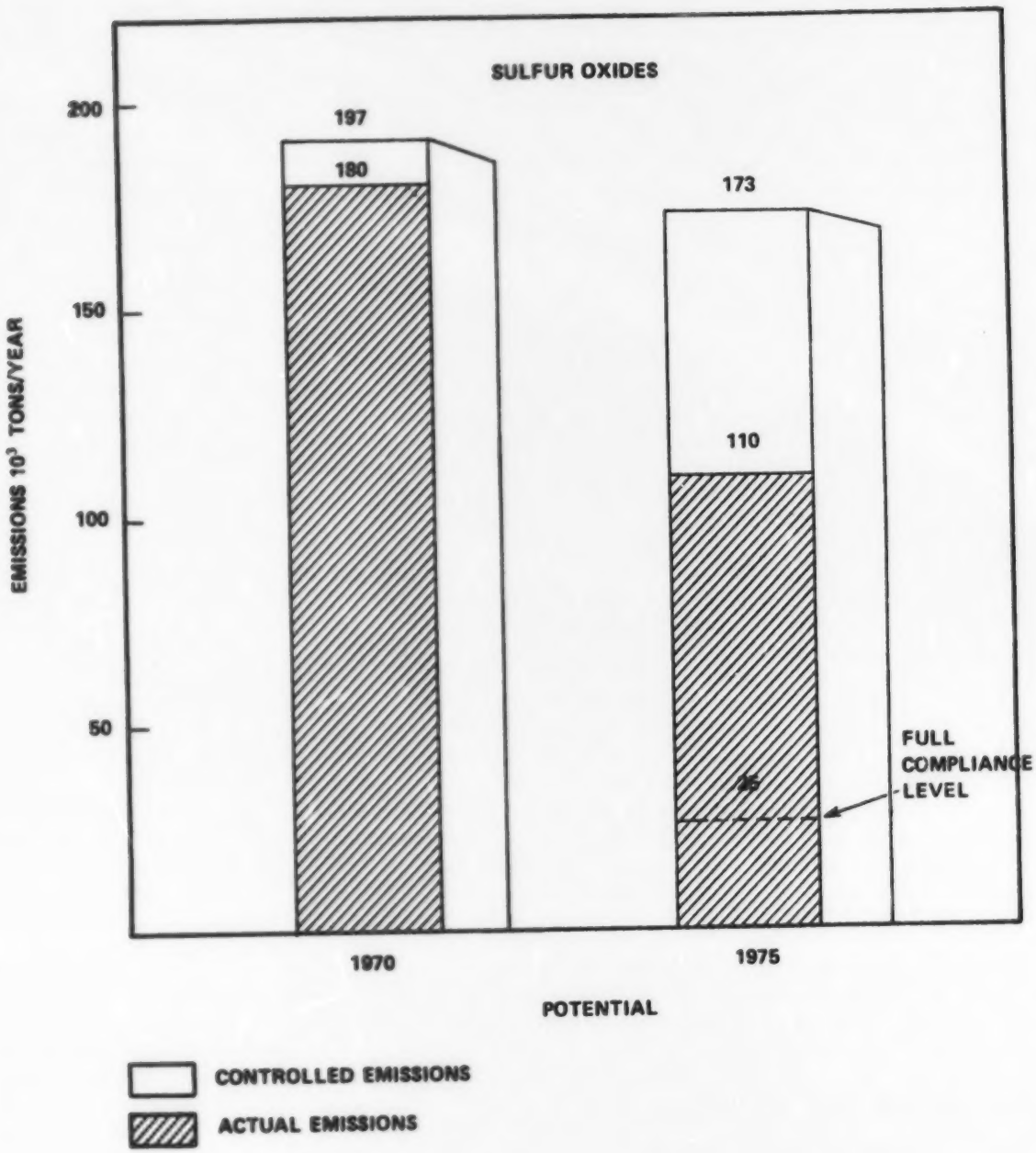

Figure 6B. Integrated Iron and Steel Mills and Coke Plants

resulted in a 39 percent reduction in actual emissions (to 110,000 tons per year in 1975 from 180,000 tons per year in 1970). Translated to reduction in emissions, 70,000 tons per year of sulfur oxides from coke ovens were under control in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 173,000 tons, will require 86 percent control to 25,000 tons per year. At compliance with emission limitations, 155,000 tons of sulfur oxides from coke ovens will be under control that were not under control in 1970. Through 1975, 45 percent of the compliance level had been achieved.

5. Petroleum Refineries.

Petroleum refineries accounted for less than 1 percent of all actual particulate and 5 percent of all actual sulfur oxide emissions in 1975. Figures 7A and 7B illustrate potential and actual particulate and sulfur oxide emissions from petroleum refineries for 1970 and 1975 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards. If Claus units were considered as an SO_2 control device for refinery operations rather than an integral part of refinery operations, 1975 potential emissions from refinery operations would increase from 1.76×10^6 tons to 9.1×10^6 tons, with a corresponding increase in emission reductions under compliance.

Particulates--Between 1970 and 1975, potential emissions increased by 14 percent (to 324,000 tons per year in 1975 from 283,000 tons per year in 1970). Existing abatement programs had achieved an overall degree of control of 52 percent in 1970. By 1975, while the overall degree of control had increased to 54 percent, actual emissions had increased by 9 percent (to 148,000 tons per year in 1975 from 136,000 tons per year in 1970). This increase in actual emissions indicates although additional controls have been installed, not enough had been added between 1970 and 1975 to offset the 14 percent growth in potential emissions. Analysis of 1975 and compliance degree of control (approximately 55 percent in both cases) indicates that SIP requirements were not sufficiently stringent to accommodate growth without an overall increase in actual emissions. The additional controls, however, did result in 29,000 tons of particulates being under control in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 324,000 tons, will require 55 percent control to 146,000 tons per year. At compliance with emission limitations, 31,000 tons of particulates from petroleum refineries will be under control that were not under control in 1970. Through 1975, 95 percent of the compliance level for particulates had been achieved.

Sulfur Oxides--For the purposes of this report, Claus sulfur recovery units using refinery feedstocks are considered as being an integral part of the refinery. Sulfur oxide emissions are considered as emanating from three primary processes: catalytic cracking, process heat and boilers, and Claus sulfur recovery plants. It has been assumed that the price of sulfur between

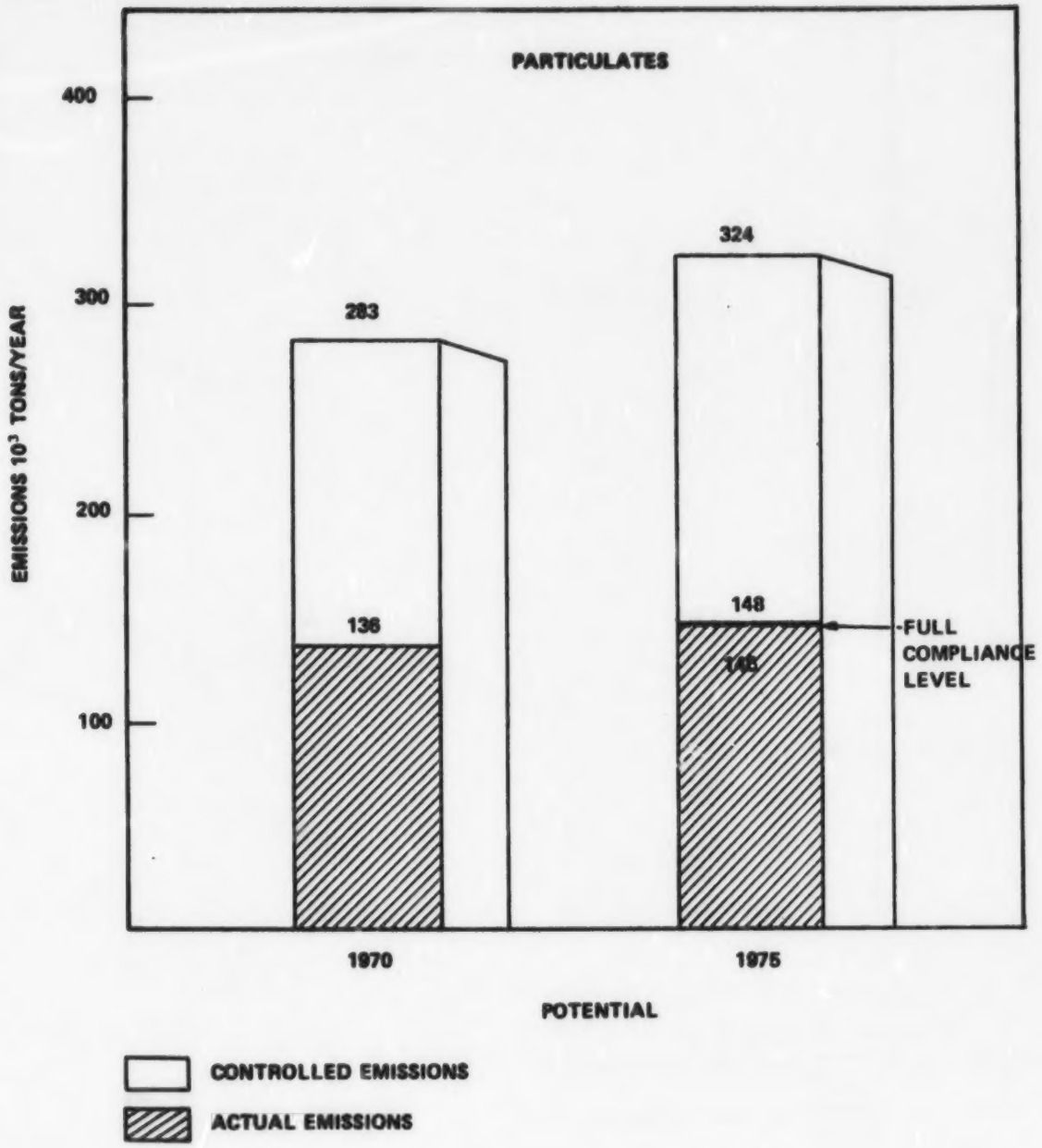

Figure 7A. Petroleum Refineries

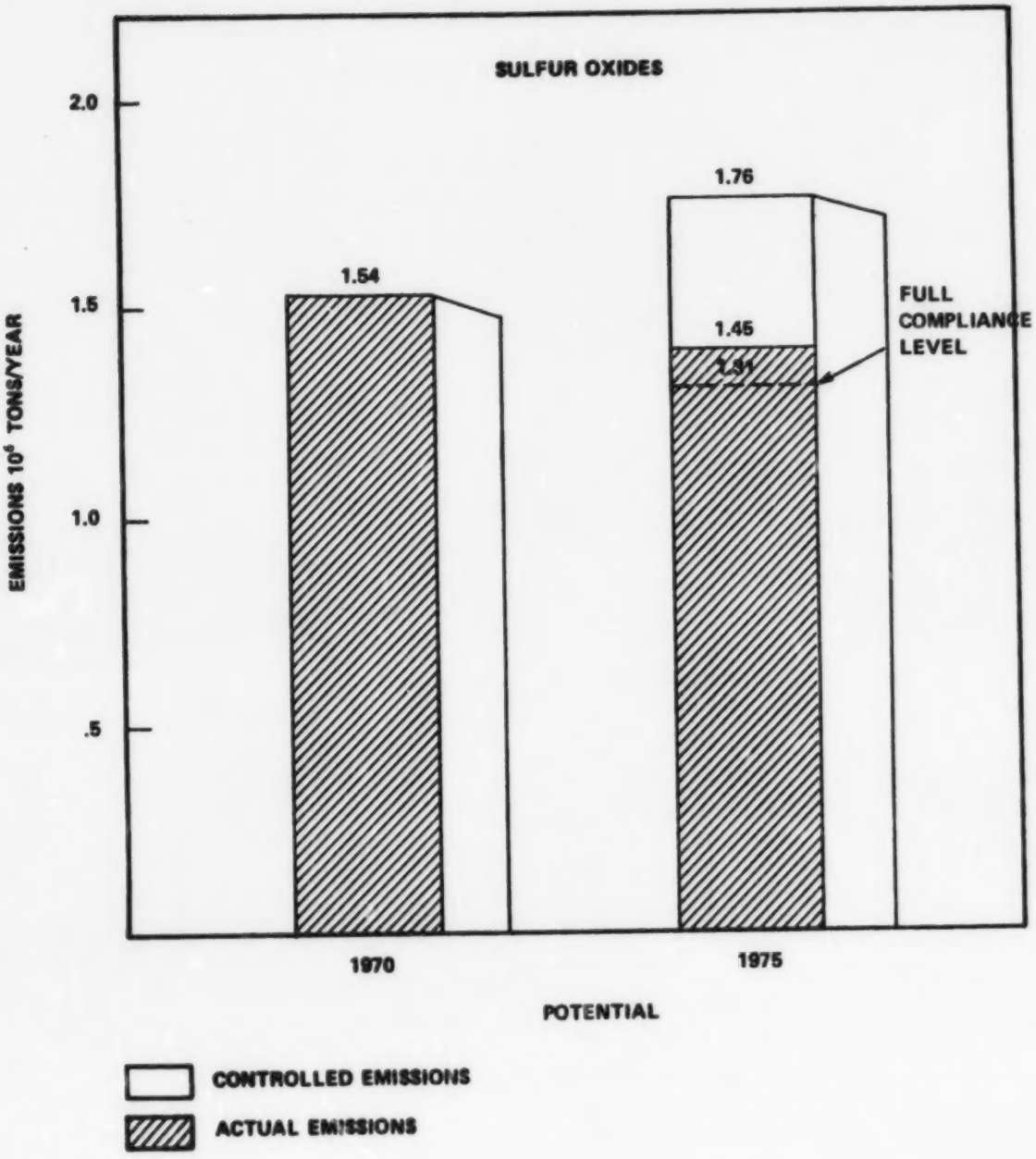

Figure 7B. Petroleum Refineries

1970 and 1975 has been a sufficient economic inducement for the recovery of sulfur from refinery off-gases. Thus, emissions reduction equivalent to the sulfur recovered in Claus units cannot be credited to environmental or abatement programs.

Between 1970 and 1975, potential sulfur oxide emissions increased by 14 percent (to 1.76 million tons per year in 1975 from 1.54 million tons per year in 1970). By 1975 an overall degree of control of 15 percent resulted in a 3 percent reduction in actual emissions (to 1.50 million tons per year in 1975 from 1.54 million tons per year in 1970). Translated to reduction in emissions, 261,000 tons per year of sulfur oxides from petroleum refineries were under control in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 1.76 million tons, will require 25 percent control to 1.31 million tons per year. At compliance with emission limitations, 447,000 tons of sulfur from petroleum refineries will be under control that were not in 1970. Through 1975, 58 percent of the compliance level for sulfur oxides had been achieved.

6. Primary Copper, Lead, Zinc, and Aluminum Smelters.

Primary smelters accounted for less than 1 percent of all actual particulate and 9 percent of all actual sulfur oxide emissions in 1975. Figures 8A and 8B illustrate potential and actual particulate and sulfur oxide emissions for 1970 and 1974 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards. This estimate of reduction in emissions does not include emissions reductions resulting from smelter closings as a result of State actions. Between 1970 and 1975, 18 percent of the 1970 primary zinc smelter capacity was shut down by State orders.

Particulates--Between 1970 and 1975, as a result of closure of some smelters through State environmental actions and decreased activity due to economic conditions, potential emissions decreased by 5 percent (to 1.55 million tons per year in 1975 from 1.64 million tons per year in 1970). Emission controls installed prior to 1970 had achieved an overall degree of control of 88 percent. By 1975 the overall degree of control had increased to 91 percent and had resulted in a 23 percent reduction in actual emissions (to 190,000 tons per year in 1975 from 145,000 tons per year in 1970). Translated to reduction in emissions, 45,000 tons per year of particulate from primary smelter operations were under control in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 1.55 million tons, will require 94 percent control to 100,000 tons per year. At compliance with emission limitations, 90,000 tons of particulates from primary smelter operations will be under control that were not under control in 1970. Through 1975, 50 percent of the compliance level for particulates had been achieved.

Sulfur Oxides--Between 1970 and 1975, as a result of closure of some smelters through State environmental actions and decreased activity due to

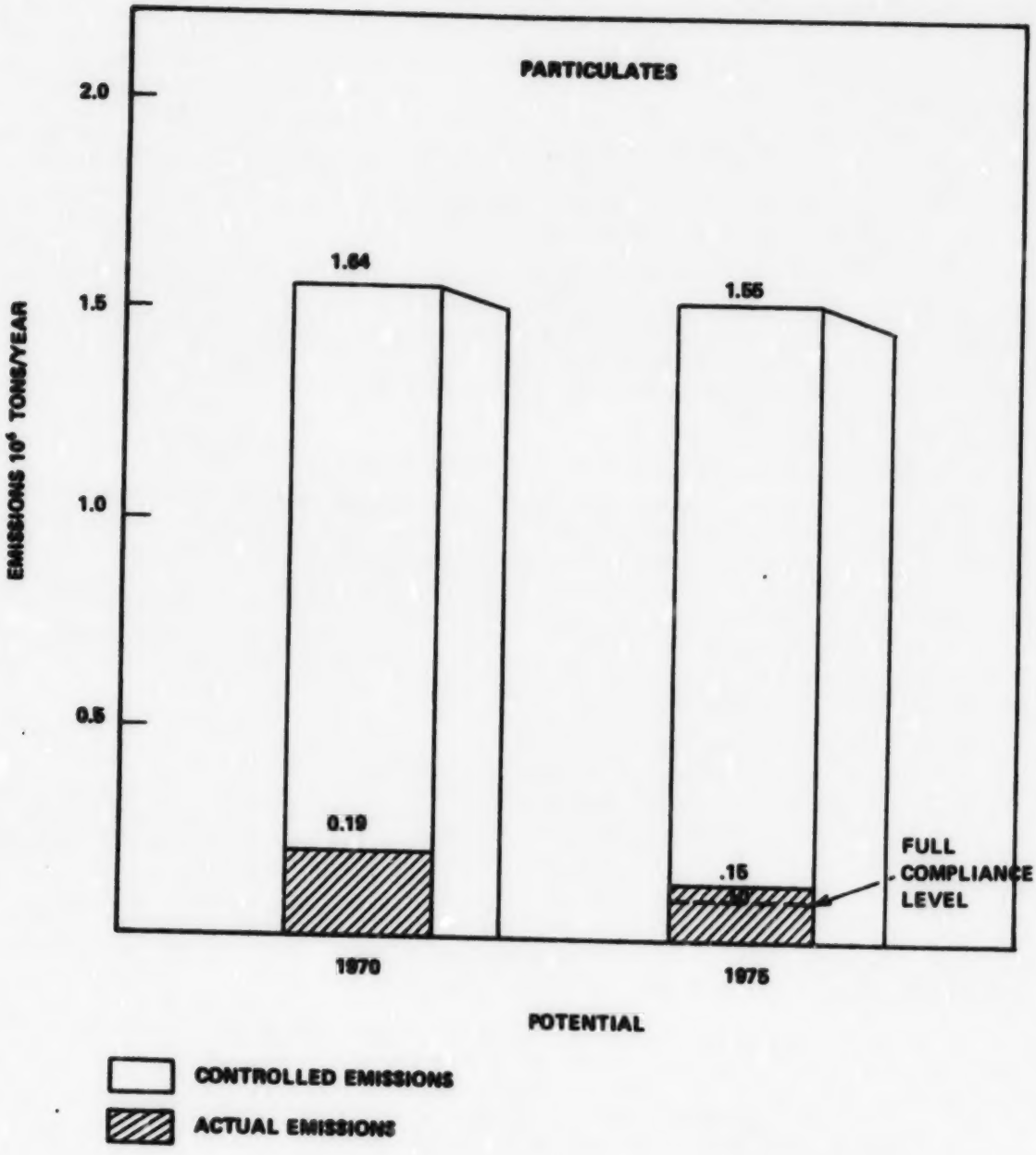

Figure 8A. Primary Smelters

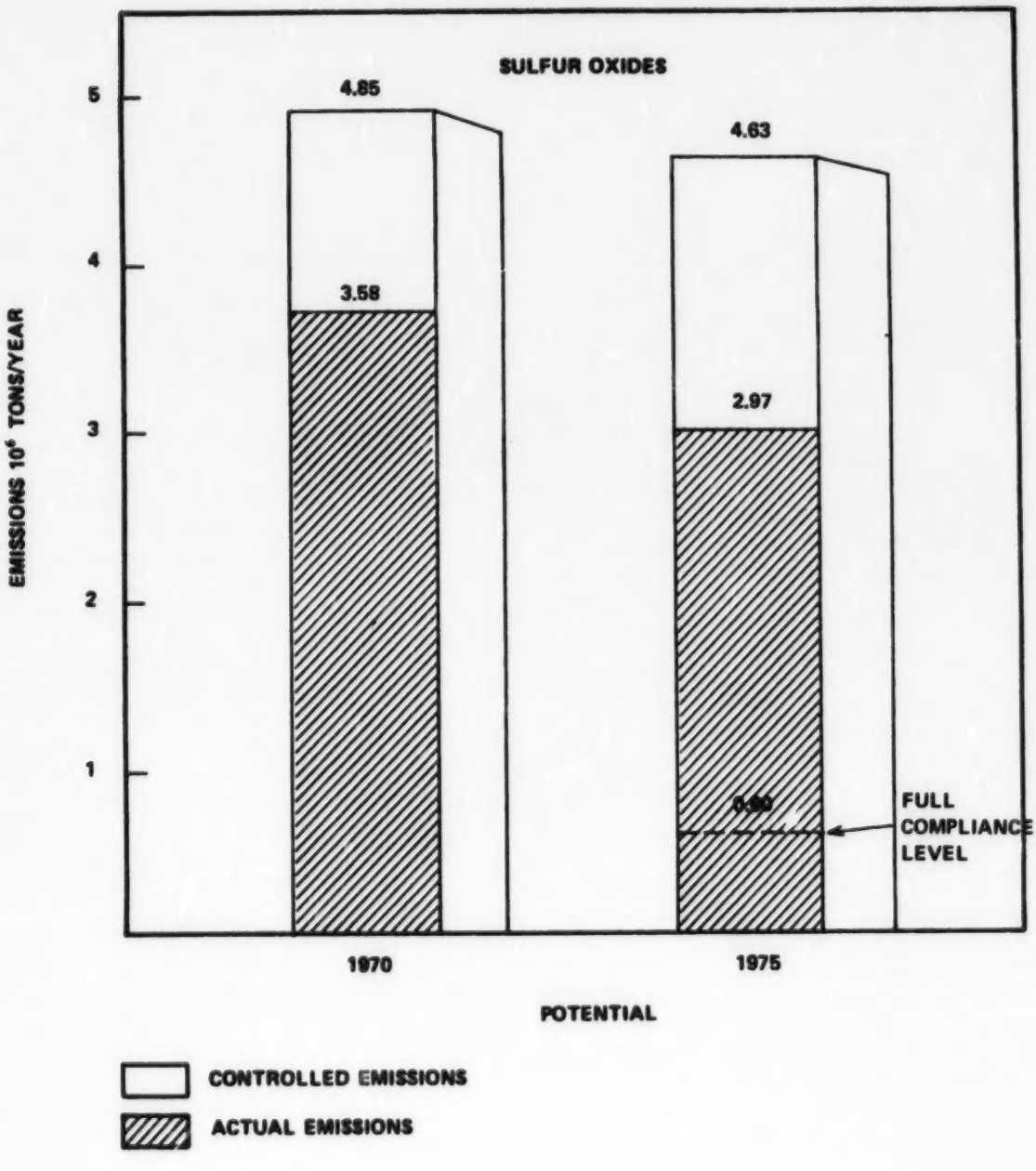

Figure 8B. Primary Smelters

economic conditions, potential emissions decreased by 5 percent (to 4.63 million tons per year in 1975 from 4.85 million tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 26 percent by 1970. By 1975 the overall degree of control had increased to 36 percent and had resulted in a 17 percent reduction in actual emissions (to 2.97 million tons per year in 1975 from 3.58 million tons per year in 1970). Translated to reduction in emissions, 615,000 tons per year of sulfur oxide from primary smelter operations were under control in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 4.63 million tons, will require 87 percent control to 603,000 tons per year. At compliance with emission limitations, 2.98 million tons of sulfur oxide from primary smelter operations will be under control that were not under control in 1970. Through 1975, 21 percent of the compliance level for sulfur oxides had been achieved.

7. Portland Cement Plants.

Portland cement plants accounted for 2 percent of all actual particulate and 2 percent of all actual sulfur oxide emissions in 1975. Figures 9A and 9B illustrate potential and actual particulate and sulfur oxide emissions from Portland cement plants for 1970 and 1975 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, as a result of economic conditions, potential emissions decreased by 9 percent (to 9.6 million tons per year in 1975 from 10.6 million tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 91 percent by 1970. By 1975 the overall degree of control had increased to 97 percent and had resulted in a 66 percent reduction in actual emissions (to 305,000 tons per year in 1975 from 906,000 tons per year in 1970). Translated to reduction in emissions, 601,000 tons per year of particulates from portland cement plants were under control in 1975 that were not under control in 1970. A large part of this reduction is due to a decrease in potential emissions. The remainder can be attributed to increased control--97 percent in 1975 vis-a-vis 91 percent in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 9.6 million tons, will require 99 percent control to 66,000 tons per year. At compliance with emission limitations, 840,000 tons of particulates from portland cement plants will be under control that were not under control in 1970. Through 1975, 72 percent of the compliance level for particulates had been achieved.

Sulfur Oxides--Potential emissions of sulfur oxides increased by 10 percent between 1970 and 1975. Examination of State regulations showed that none of the States accounting for over 75 percent of the industry had regulations specific to portland cement plants for sulfur oxides. Since no control is required, actual emissions were assumed to be uncontrolled and therefore the same as potential for both years. Although sulfur oxide emissions from portland

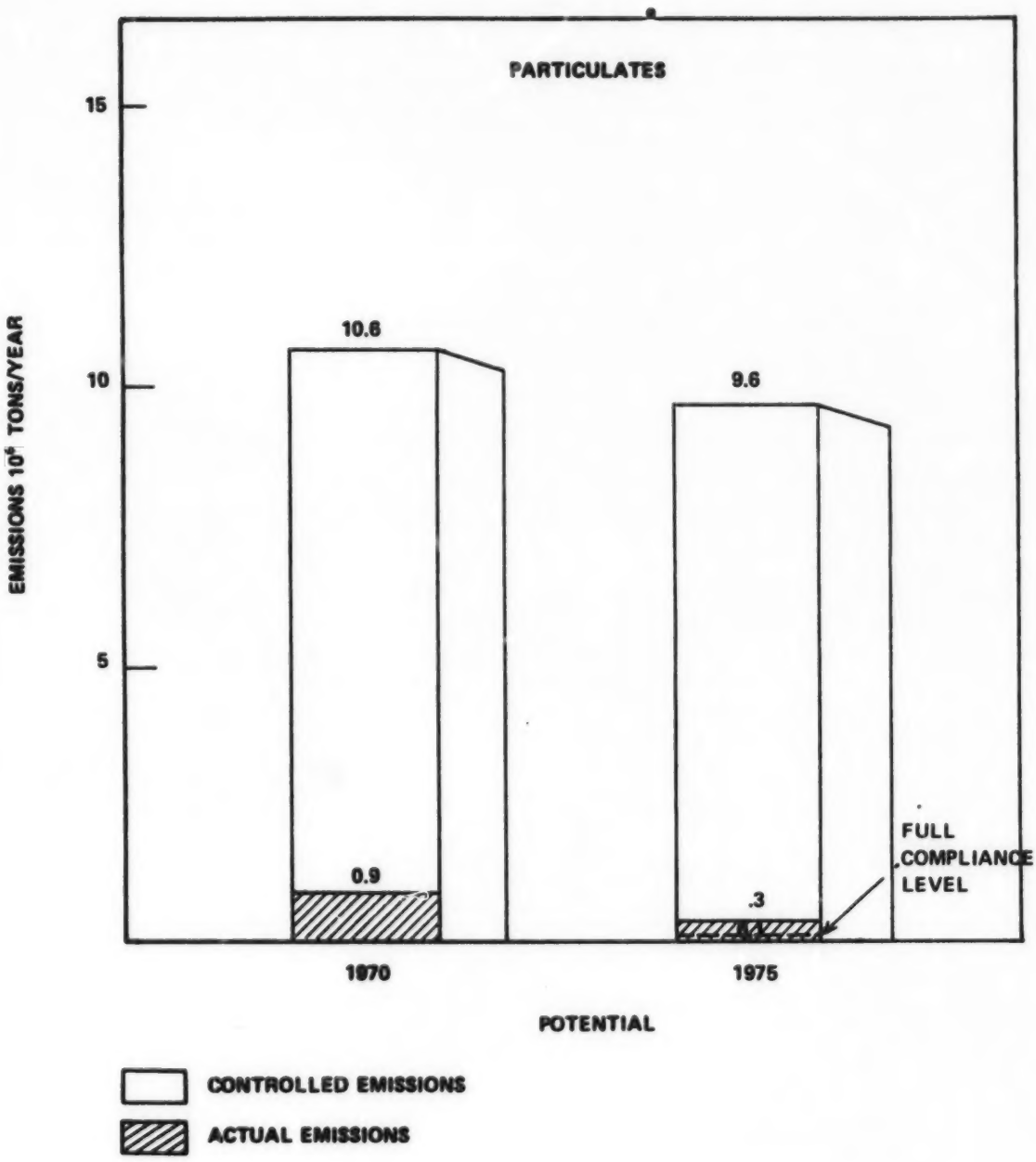

Figure 9A. Portland Cement Plants

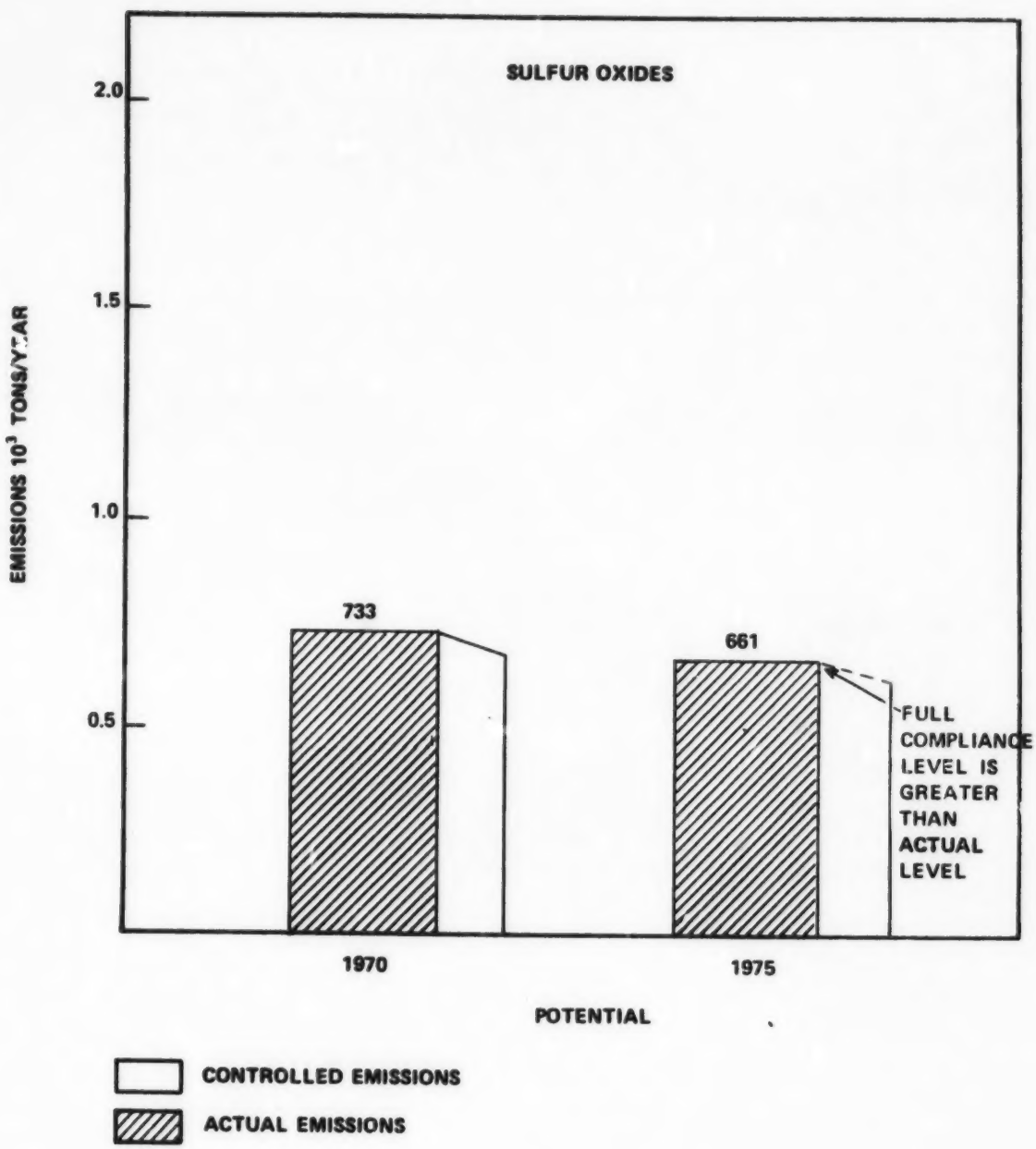

Figure 9B. Portland Cement Plants

cement plants appear to require no control when averaged on a national basis, there may be some localized requirements for control where more stringent local regulations apply.

8. Municipal Refuse Incinerators

Municipal refuse incinerators accounted for less than 1 percent of all actual particulate emissions in 1975. Figure 10 illustrates potential and actual particulate emissions from municipal refuse incinerators for 1970 and 1975 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, potential emissions increased by 10 percent (to 203,000 tons per year in 1975 from 184,000 tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 43 percent by 1970. By 1975 the overall degree of control had increased to 64 percent and had resulted in a 30 percent reduction in actual emissions (to 73,000 tons per year in 1975 from 105,000 tons per year in 1970). Translated to reduction in emissions, 51,000 tons per year of particulate from municipal incinerators were under control in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 203,000 tons, will require 92 percent control to 16,000 tons per year. At compliance with emission limitations, 108,000 tons of particulate from municipal incinerators will be under control that were not under control in 1970. Through 1975, 47 percent of the compliance level for particulates had been achieved.

9. Sulfuric Acid Plants

Sulfuric acid plants accounted for 1 percent of all actual sulfur oxide emissions in 1974. Figure 11 illustrates potential and actual sulfur oxide emissions from sulfuric acid plants for 1970 and 1974 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards.

Sulfur Oxides--For the base year, 1970, actual emissions were assumed to be the same as potential emissions since sulfur oxide emission control in previous years was accomplished by improved process controls rather than by stack gas cleaning. Between 1970 and 1975, potential emissions increased by 8 percent (to 626,000 tons per year in 1975 from 581,000 tons per year in 1970). By 1975 an overall degree of control of 44 percent had been achieved. This resulted in a 40 percent reduction in actual emissions (to 350,000 tons per year in 1975 from 581,000 tons per year in 1970). Translated to reduction in emissions, 276,000 tons per year of sulfur oxides from sulfuric acid plants were under control in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 626,000 tons, will require 71 percent control to 183,000 tons per year. At compliance with emission limitations, 443,000 tons of sulfur oxides from sulfuric acid plants will be under control that were not under

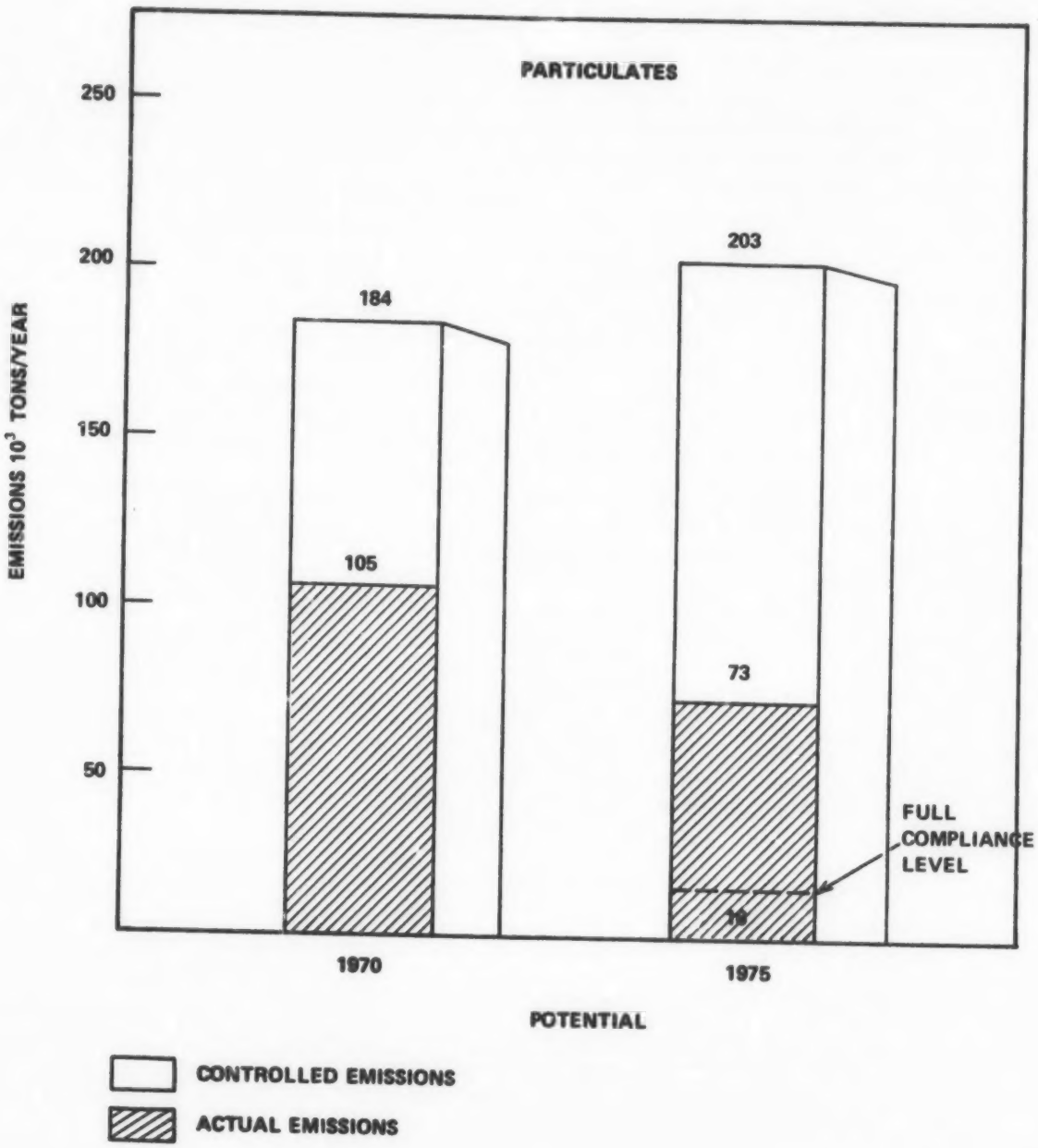

Figure 10. Municipal Refuse Incinerators

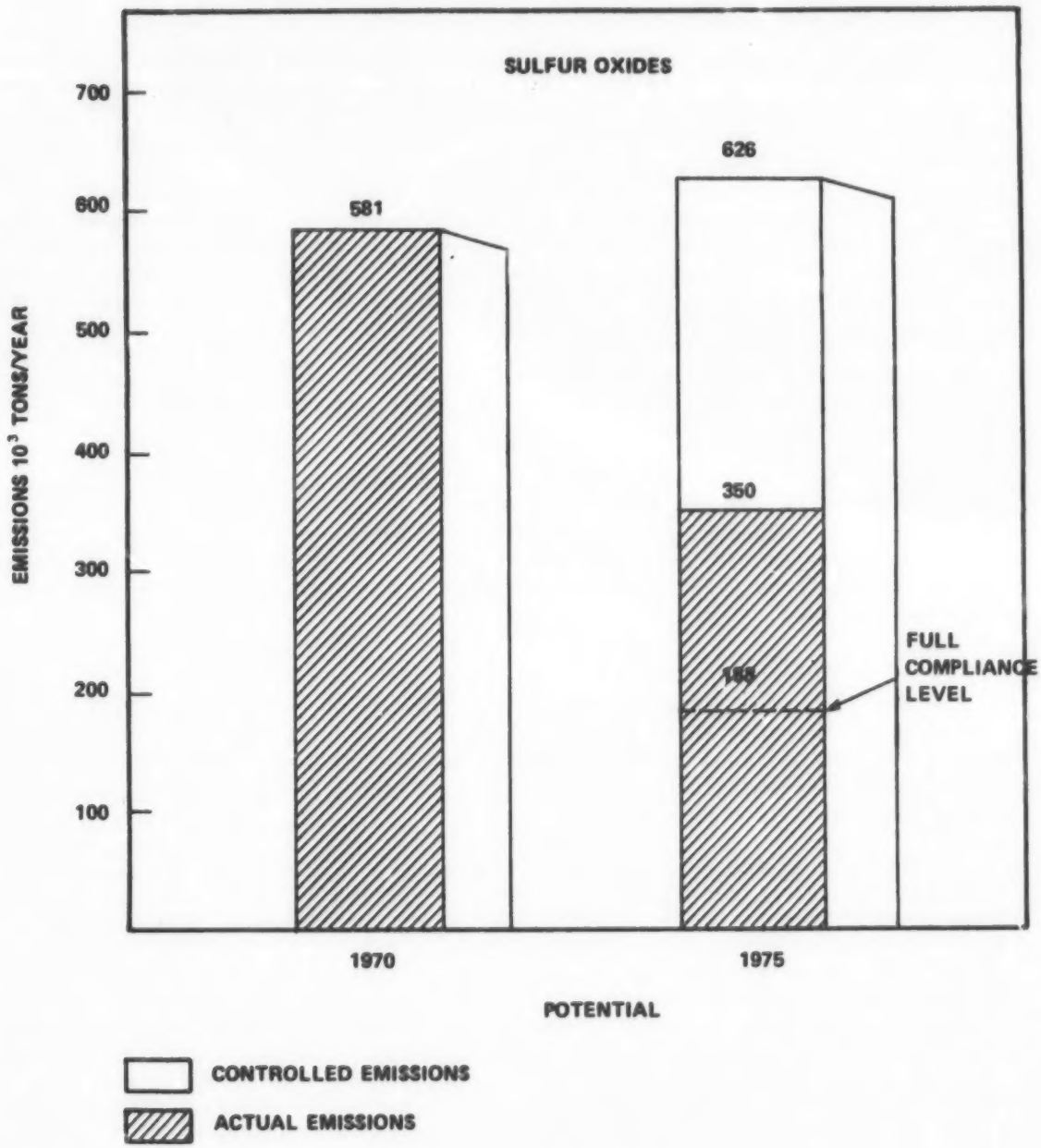

Figure 11. Sulfuric Acid Plants

control in 1970. Through 1975, 62 percent of the compliance level for sulfur oxides had been achieved.

10. Phosphate Fertilizer Plants

Phosphate fertilizer plants accounted for less than 1 percent of all actual particulate emissions in 1975. Figure 12 illustrates potential and actual particulate emissions from phosphate fertilizer plants for 1970 and 1975 and full compliance level emission, based on 1975 activity, for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, potential emissions decreased slightly by 3 percent (to 167,000 tons per year in 1975 from 172,000 tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 86 percent by 1970. By 1975 the overall degree of control had increased to 92 percent and had resulted in a 42 percent reduction in actual emissions (to 14,000 tons per year in 1975 from 24,000 tons per year in 1970). Translated to reduction in emissions, 10,000 tons per year of particulates from the phosphate fertilizer industry were under control in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 167,000 tons, will require 93 percent control to 12,000 tons per year. At compliance with emission limitations, 12,000 tons of particulates from the phosphate fertilizer industry will be under control that were not in 1970. Through 1975, 83 percent of the compliance level for particulates had been achieved.

11. Ferroalloy Plants

Ferroalloy plants accounted for less than 1 percent of all actual particulate emissions in 1974. Figure 13 illustrates potential and actual particulate emissions from ferroalloy plants for 1970 and 1975 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, as a result of economic conditions, potential emissions decreased by 14 percent (to 313,000 tons per year in 1975 from 366,000 tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 81 percent by 1970. By 1975 the overall degree of control had increased to 89 percent and had resulted in a 52 percent reduction in actual emissions (to 34,000 tons per year in 1975 from 71,000 tons per year in 1970). Translated to reduction in emissions, 37,000 tons per year of particulate from ferroalloy plants were under control in 1975 that were not under control in 1970. A part of this reduction is due to a decrease in potential emissions, but the added emission control is the primary cause of this reduction. Added controls resulted in a decrease of 25,000 tons per year.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 313,000 tons, will require 91 percent control to 29,000 tons

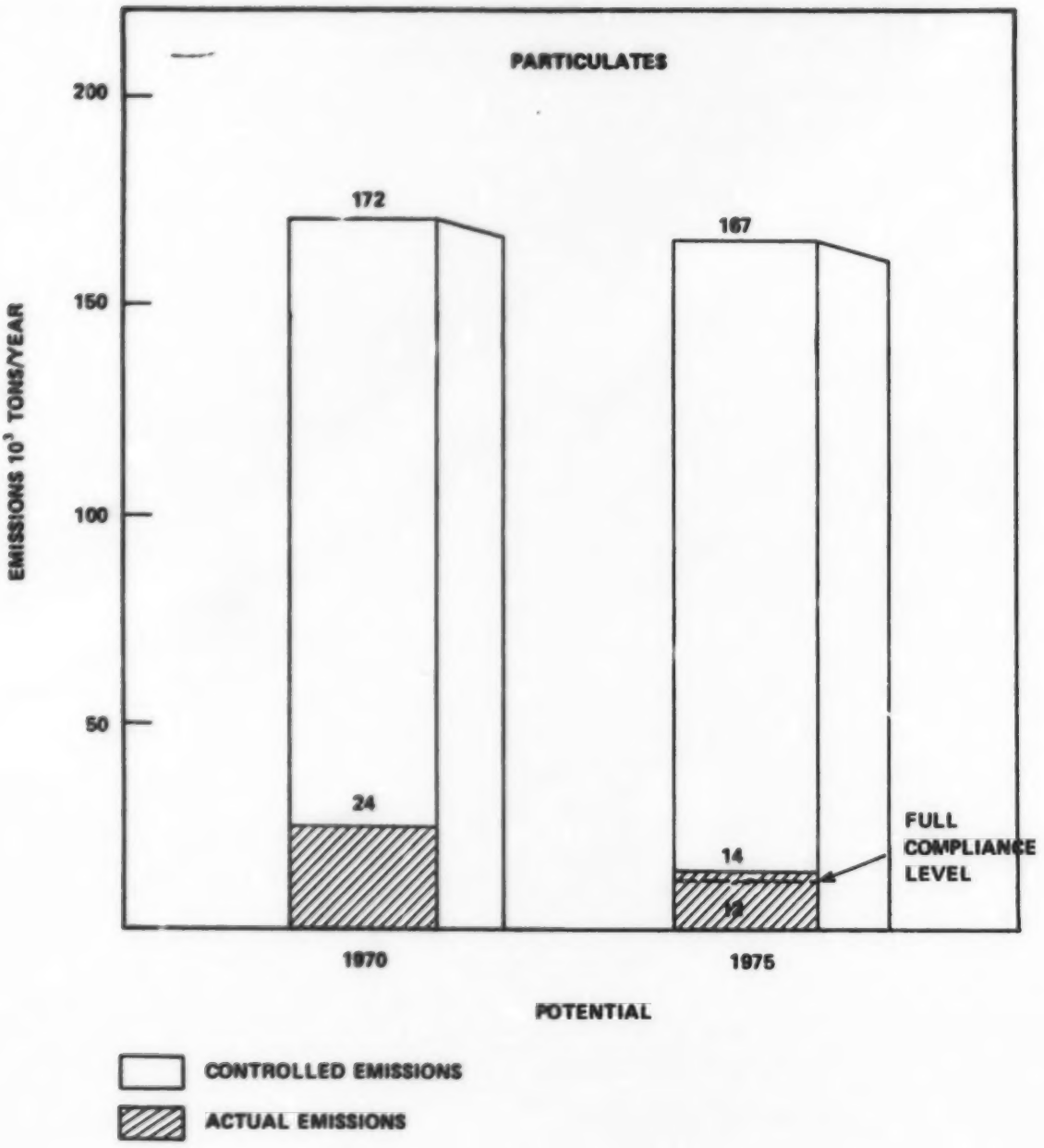

Figure 12. Phosphate Fertilizer Plants

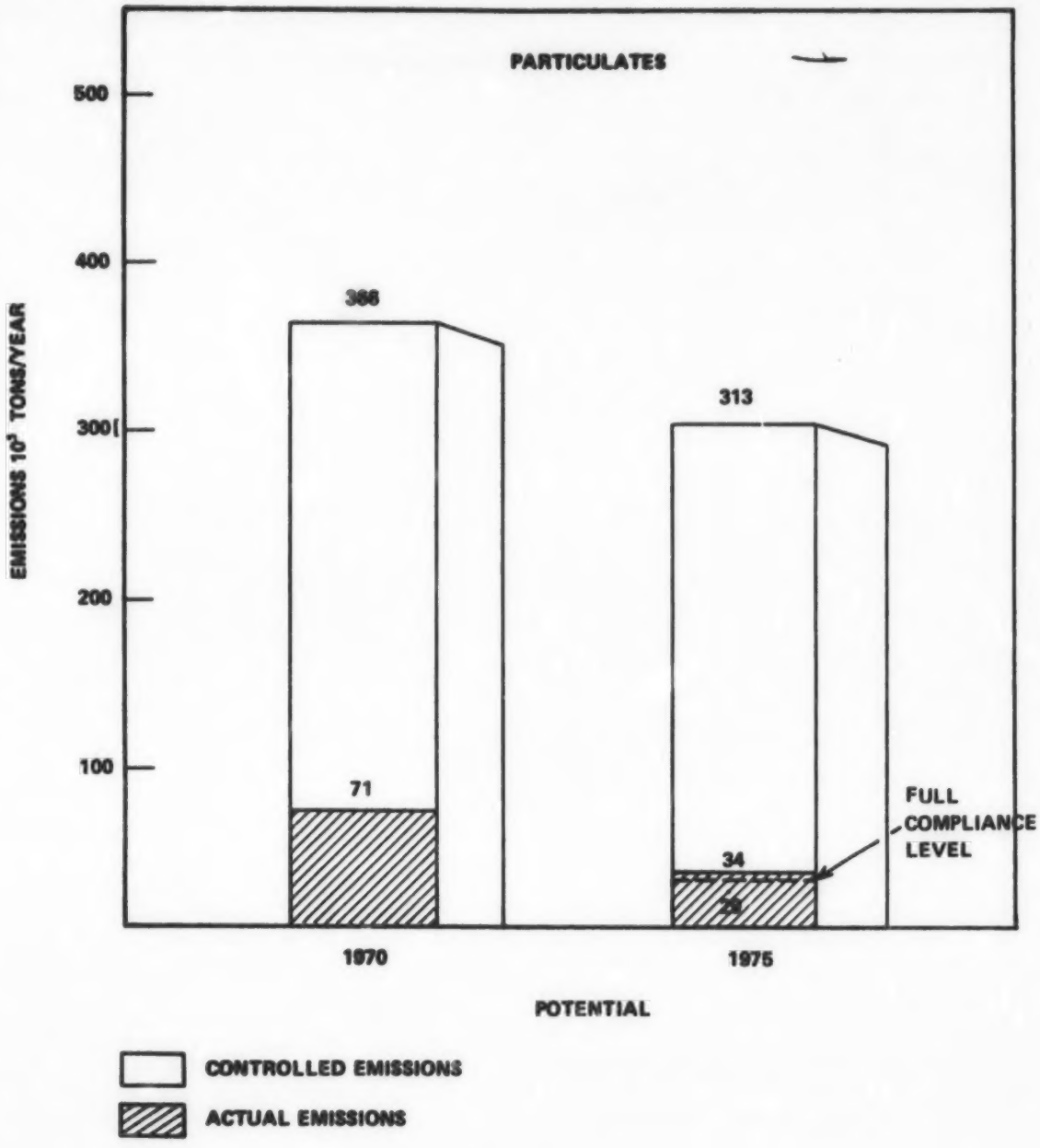

Figure 13. Ferroalloy Plants

per year. At compliance with emission limitations, 42,000 tons of particulates from ferroalloy plants will be under control that were not under control in 1970. Through 1975, 88 percent of the compliance level for particulates had been achieved.

12. Asphalt Concrete Plants

Asphalt concrete plants accounted for approximately 1 percent of all actual particulate emissions in 1975. Figure 14 illustrates potential and actual particulate emissions from asphalt concrete plants for 1970 and 1974 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, potential emissions increased slightly by 1 percent (to 7.09 million tons per year in 1975 from 7.00 million tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 92 percent by 1970. By 1975 the overall degree of control had increased to 97.1 percent and had resulted in a 70 percent reduction in actual emissions (to 203,000 tons per year in 1975 from 526,000 tons per year in 1970). Translated to reduction in emissions, 413,000 tons per year of particulates from asphalt concrete plants were under control in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 7.09 million tons, will require 98.3 percent control to 120,000 tons per year. At compliance with emission limitations, 496,000 tons of particulates from asphalt concrete plants will be under control that were not in 1970. Through 1975, 83 percent of the compliance level for particulates had been achieved.

13. Coal-Cleaning Plants

Coal-cleaning plants accounted for less than 1 percent of all actual particulate emissions in 1975. Figure 15 illustrates potential and actual particulate emissions from coal-cleaning plants for 1970 and 1975 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, potential emissions decreased by 45 percent (to 372,000 tons per year in 1975 from 671,000 tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 68 percent by 1970. By 1975 the overall degree of control had increased to 91 percent. Actual 1975 emissions were 16 percent of those in 1970 (to 35,000 tons per year in 1975 from 217,000 tons per year in 1970). While drastic reduction in potential emissions from decreased activity was responsible for most of this, a reduction of 86,000 tons per year can be attributed to the increased 1975 control level.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 361,000 tons, will require 97 percent control to 11,000 tons per year. At compliance with emission limitation, 206,000 tons of particulates from coal-cleaning plants will be under control that were not in 1970.

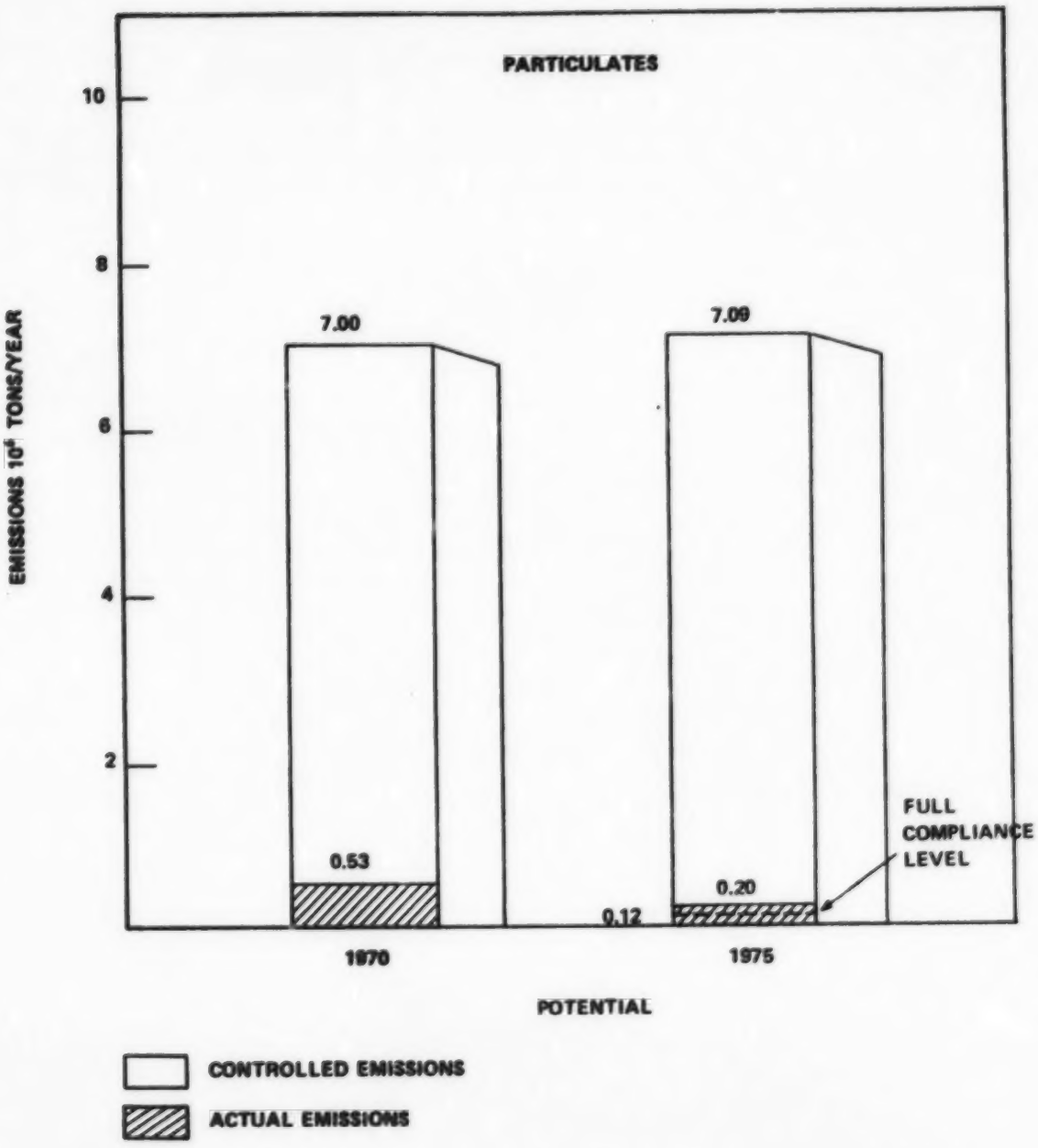

Figure 14. Asphalt Concrete Plants

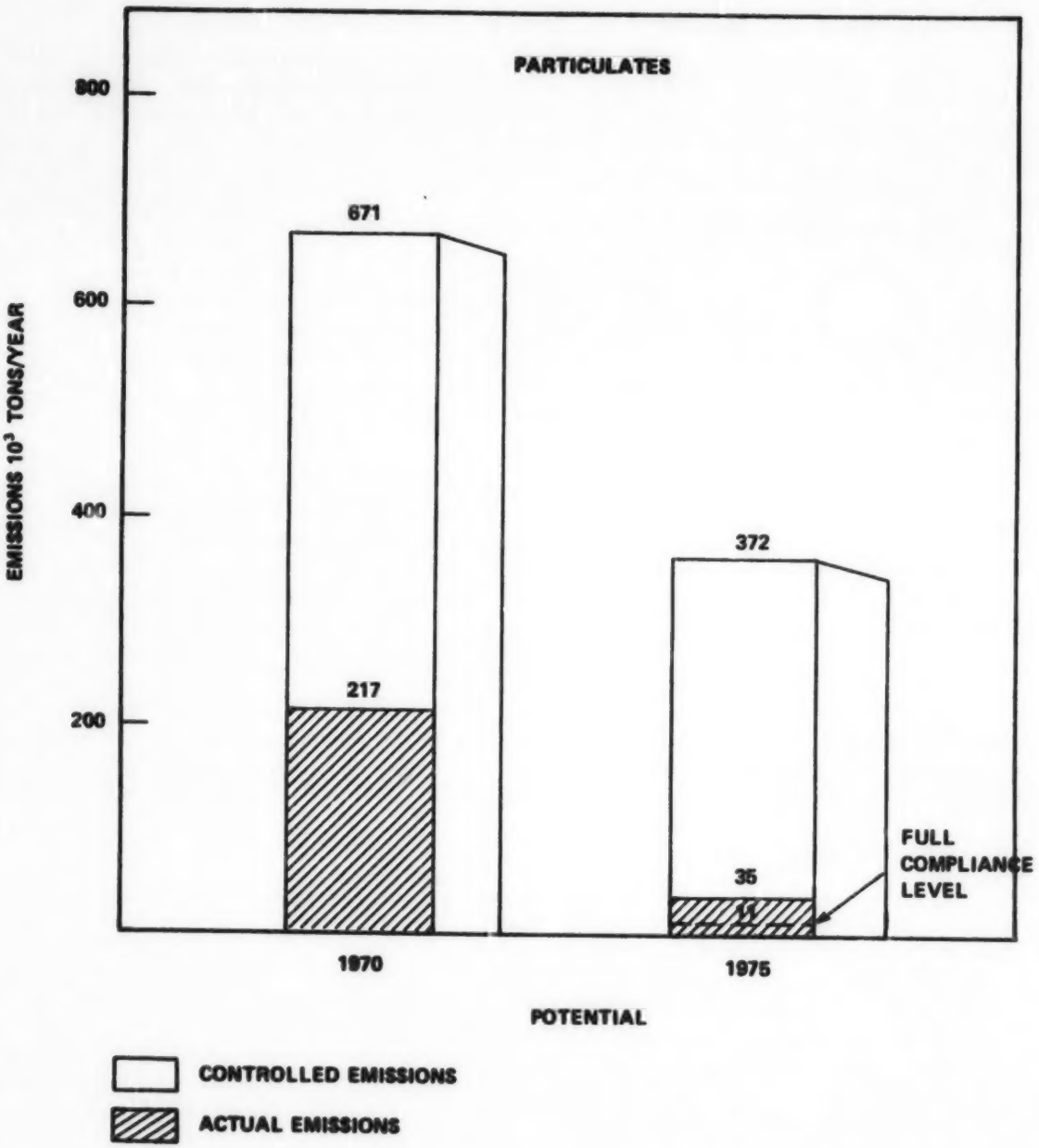

Figure 15. Coal Cleaning Plants

Through 1975, 88 percent of the compliance level for particulates had been achieved.

14. Kraft and Sulfite Pulp Mills

Kraft and sulfite pulp mills accounted for approximately 1 percent of all actual particulate emissions in 1975. Figure 16 illustrates potential and actual particulate emissions from kraft and sulfite pulp mills for 1970 and 1974 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, potential emissions increased by 21 percent (to 3.79 million tons per year in 1975 from 3.13 million tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 91 percent by 1970. By 1975 the overall degree of control had increased to 96 percent and had resulted in a 49 percent reduction in actual emissions (to 146,000 tons per year in 1975 from 288,000 tons per year in 1970). Translated to reduction in emissions, 798,000 tons per year of particulates from kraft and sulfite pulp mills were under control in 1975 that were not under control in 1970.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 3.79 million tons, will require 99 percent control to 38,000 tons per year. At compliance with emission limitations, 906,000 tons of particulates from kraft and sulfite pulp mills will be under control that were not in 1970. Through 1975, 88 percent of the compliance level for particulates had been achieved.

15. Grey Iron Foundries

Grey iron foundries accounted for less than 1 percent of all actual particulate emissions in 1975. Figure 17 illustrates potential and actual emissions from grey iron foundries for 1970 and 1975 and full compliance level emissions, based on 1975 activity, for attainment of the ambient air quality standards.

Particulates--Between 1970 and 1975, potential emissions decreased by 32 percent (to 0.90 million tons per year in 1975 from 1.32 million tons per year in 1970). Existing environmental programs had achieved an overall degree of control of 88 percent by 1970. By 1975 the overall degree of control had increased to 93 percent and had resulted in a 60 percent reduction in actual emissions (to 62,000 tons per year in 1975 from 156,000 tons per year in 1970). Translated to reduction in emissions, 94,000 tons of particulates from grey iron foundries were under control in 1975 that were not under control in 1970. While reduced activity accounted for a considerable part of the reduction in actual emissions between 1970 and 1975, increased control (93 percent in 1975 vis-a-vis 88 percent in 1970) resulted in a reduction in annual emissions of 45,000 tons.

Full compliance with the SIP's, based on an estimated 1975 potential emission level of 899,000 tons, will require 95 percent control to 46,000 tons per year. At compliance with emission limitations, 110,000 tons of particulates from grey iron foundries will be under control that were not under control in 1970. Through 1975, 82 percent of the compliance level for particulates had been achieved.

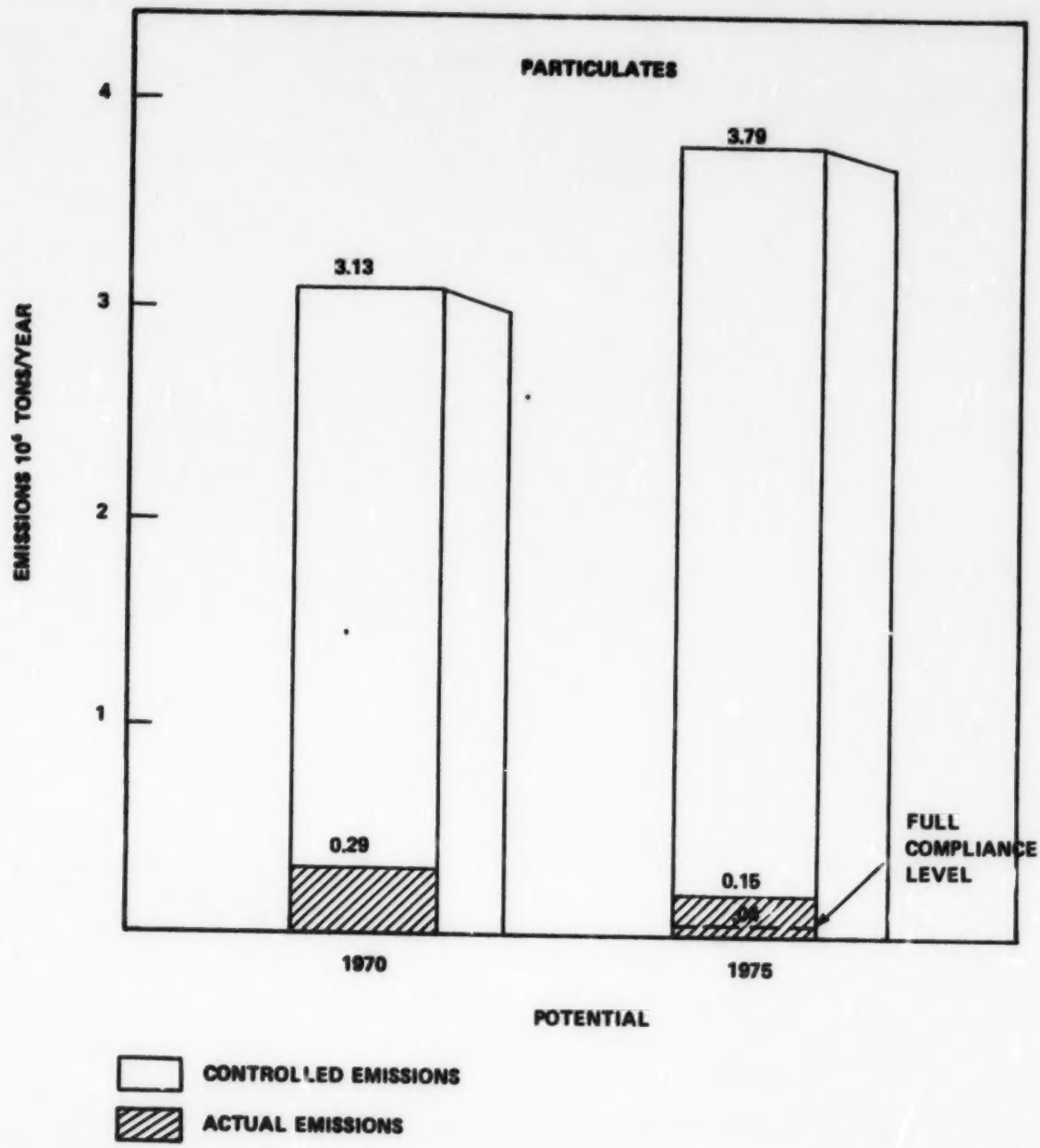

Figure 16. Kraft and Sulfate Pulp Mills

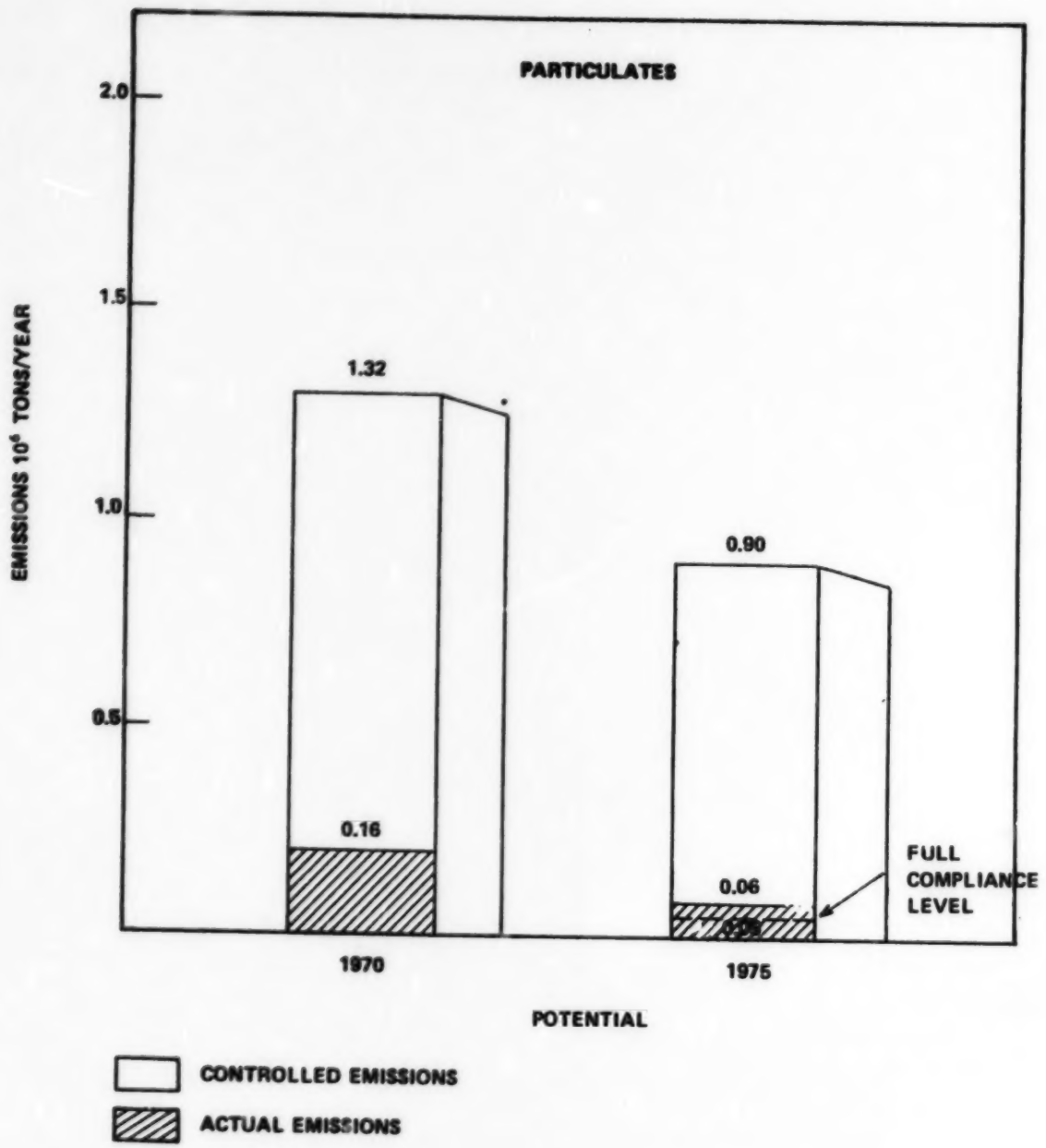

Figure 17. Gray Iron Foundries

APPENDIX A

For each industrial category, the estimated potential emissions for 1970 and 1975, and estimated actual emissions for 1970, were utilized for the analysis. Based on an assessment of each industry's 1975 compliance status with SIP-scheduled emission reductions, the actual emission rates for 1975 are calculated. These figures provide a gauge for measuring the progress each industry has made since 1970. All emissions calculations were made using production figures and estimates of pollution control factors.

Analysis of the industry categories listed indicated that they fall into three general categories: those with a small number of plants (approximately 30 or less) within the United States, those with production capacity concentrated in a small number of States, and those that are ubiquitous to the nation. The first category, typified by the primary smelter industry, is analyzed on a plant-by-plant basis using EPA national source inventories, industry background studies, trade associations' data, and Department of Commerce data. The second category, exemplified by the petroleum industry and the integrated iron and steel industry, is analyzed by synthesizing the above factors on a national basis using data from States accounting for over 70 percent of the nationwide production. The third category--e.g., municipal incinerators--is analyzed using procedures developed specifically for the industry under study.

Provisions are included for the application of the more stringent requirements of Federal and State New Source Performance Standards (NSPS) to the 1975 portion of annual production from new or modified sources. The base year was chosen as 1970 because the national air pollution program as presently constituted dates from the 1970 Clean Air Act amendments. The 1975 data appear because that is the last <u>full</u> year for which data are available. The full compliance target levels should not be considered as representative of existing emissions since they assume full compliance with the State regulations; rather they are target levels that will be met when full compliance with SIP emission requirements is achieved.